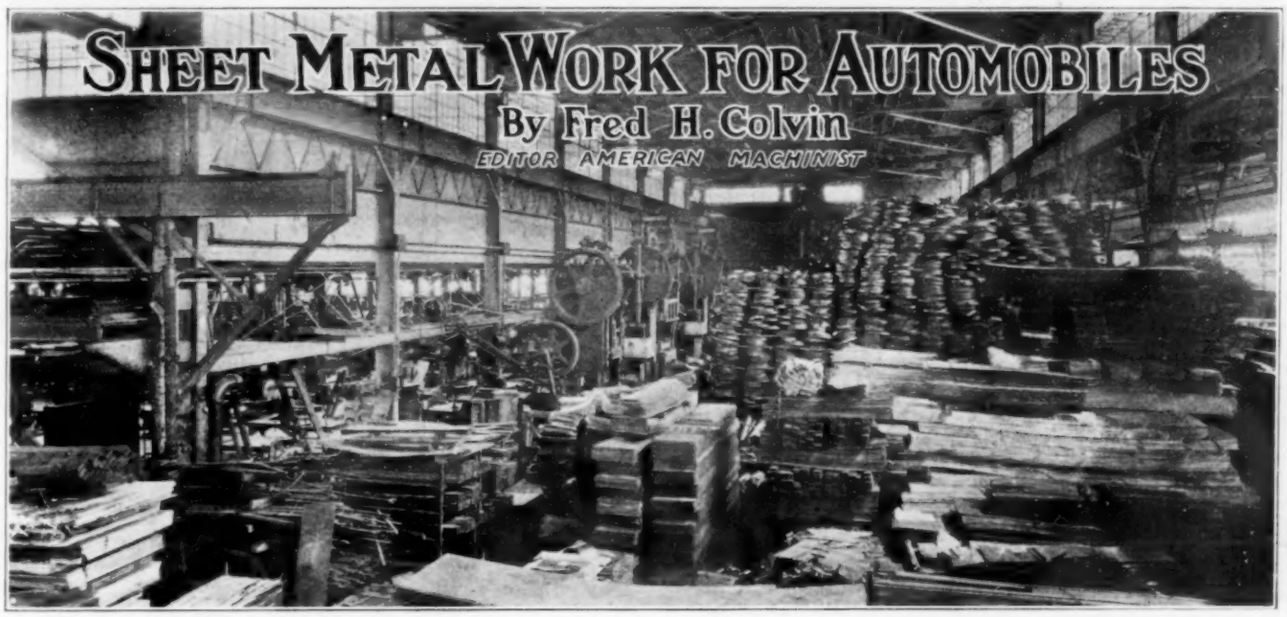
December 23, 1920 American Machinist Vol. 53, No. 26

Sheet Metal Work for Automobiles

By Fred H. Colvin
EDITOR AMERICAN MACHINIST



OF THE many developments which can be traced to the growth of the automobile industry, none is more striking than the stamping and forming of sheet metal work for frames, fenders, bodies and other parts of the modern motor car. The illustrations herewith show the way in which such work is handled in a thoroughly modern shop, the various examples being taken from the regular product for a number of well known builders.

The sheet-metal work which goes to make up the bodies and fenders of automobiles offers many problems. Some of them are recounted and their solutions explained.

The rapidity with which sheet-metal stampings are turned out in the modern shop makes the tonnage handled run up into large figures and necessitates enormous supplies of raw material being constantly on hand in order to keep the different machines in operation. The headpiece shows the receiving bay of the Michigan Stamping Co., which, as can be seen, is piled high with sheet metal in various forms and sizes. This material is handled by a travelling crane which happens to be at the other end of the runway, and it will also be noted that a runway for handling material in the other direction is to be seen at the left of the headpiece. This allows the crane from the other bay, at right angles to the storage bay, to run over into the storage section and carry material to the large machines shown in Fig. 1. This view shows the crane in the center and the stock which has been delivered. It also gives a general idea of the heavy machinery used in this work.

The machines shown in the headpiece are for cutting up the material into strips of various lengths and also preparing material for the presses, which are located in the bay, shown in Fig. 1. In the same way the shears shown in the lower left-hand corner of Fig. 1 prepare material for the presses in that line,

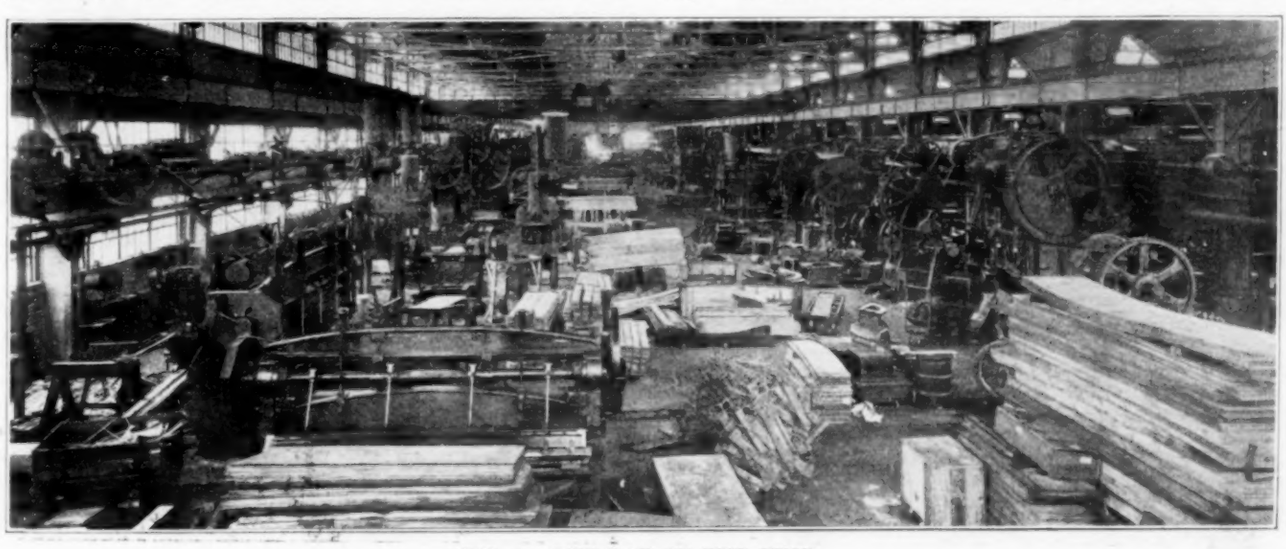


FIG. 1. ONE BAY OF THE SHOP

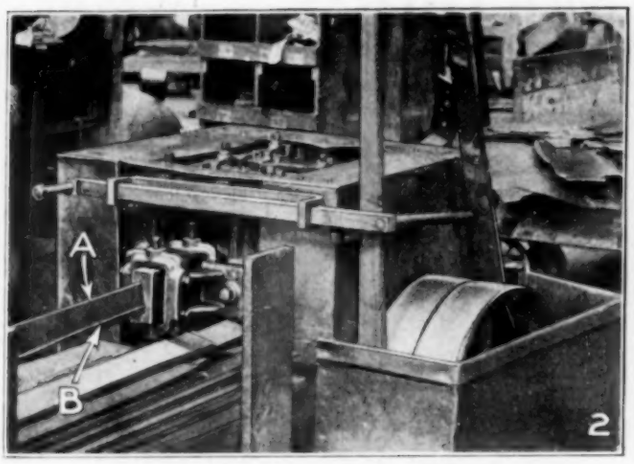


FIG. 2. WIRING THE SIDE STRIPS

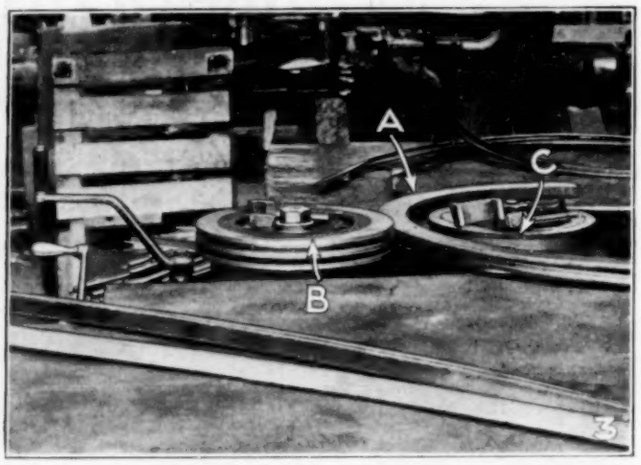


FIG. 3. BENDING TO FORM

so as to keep the stock moving progressively down the line. Some of the work done is shown in the following illustrations.

There are a number of distinctly different designs for automobile fenders, most of them being built up of two parts, as shown in the assembling and fitting operation in Fig. 13. This is quite different from the older type of fender in which the projecting edge was a narrow strip or ribbon of metal, fastened on in different ways. These ribbons were made up separately, as shown in Figs. 2 and 3, Fig. 2 showing the way in which they are wired for stiffening the edges and Fig. 3 the device used for curving to suit different conditions. In Fig. 2 the flat strip of metal *A* and the wire *B* are fed together into the curling rolls which are driven by the pulleys shown. A guide insures their entering the rolls in the correct position and as those who are at all familiar with this work know, such a machine as this will turn out wired ribbons very rapidly.

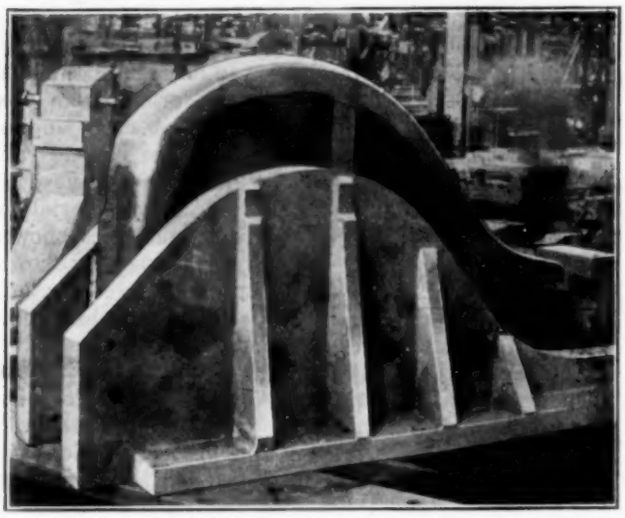


FIG. 4. A FENDER DIE

Fig. 3 shows some double wired ribbons or those wired on each edge. The ribbons are curved edgewise by running between the form *A* and the grooved roller *B*. The form is backed up by the roller *C* which allows it to move at the same peripheral speed as the roller *B*. Different forms can be substituted for *A* so as to give a machine of this kind a rather wide application. The fenders built up in this way are going out of fashion and those in which the crown is drawn down on the edge, as shown in Fig. 13, are becoming more popular, both on account of ease of manufacture and of keeping them in presentable shape.

Dies for fenders of the latter kind are shown in Fig. 4, the central portion being independent of the sides so as to allow the metal to be drawn down over its edges and down into the die. This punch is shown

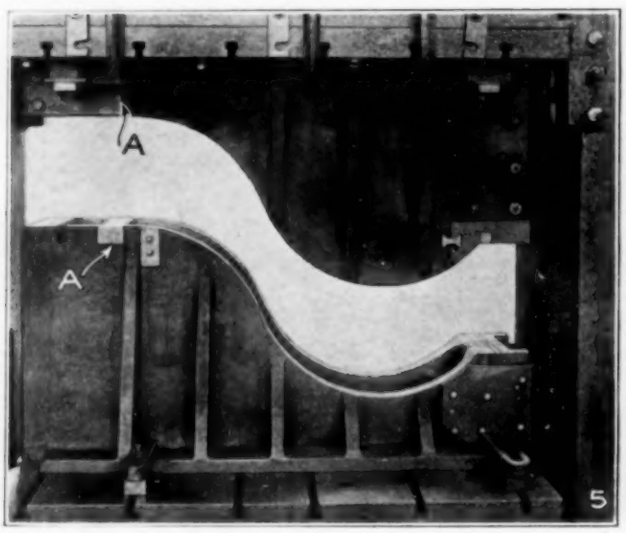


FIG. 5. DIE OPEN SHOWING DRAW PLATES

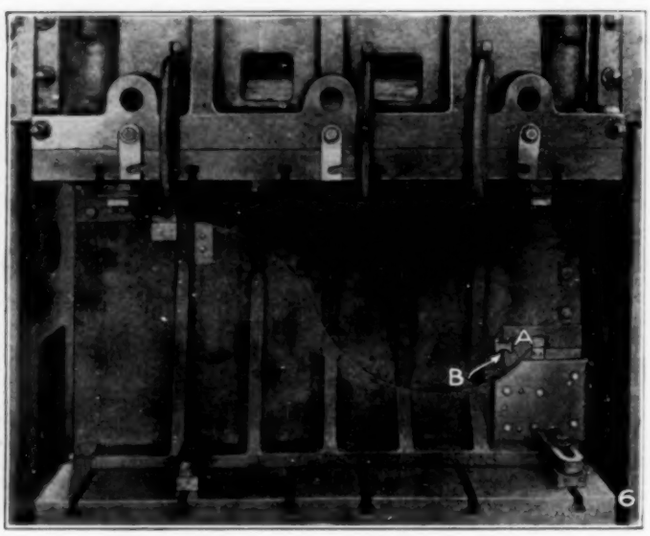


FIG. 6. THE DIE CLOSED

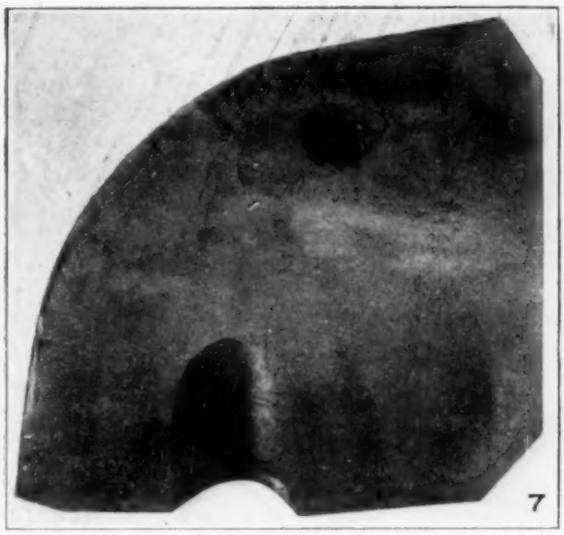


FIG. 7. BLANK FOR QUARTER PANEL

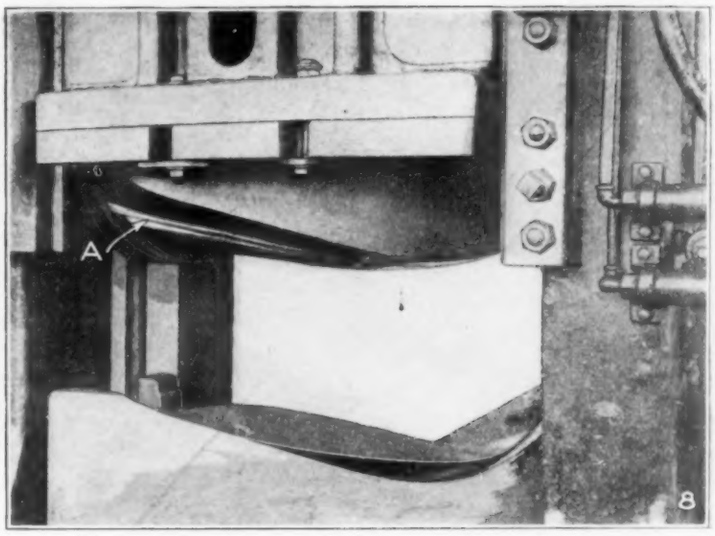


FIG. 8. PRESS FOR QUARTER PANEL

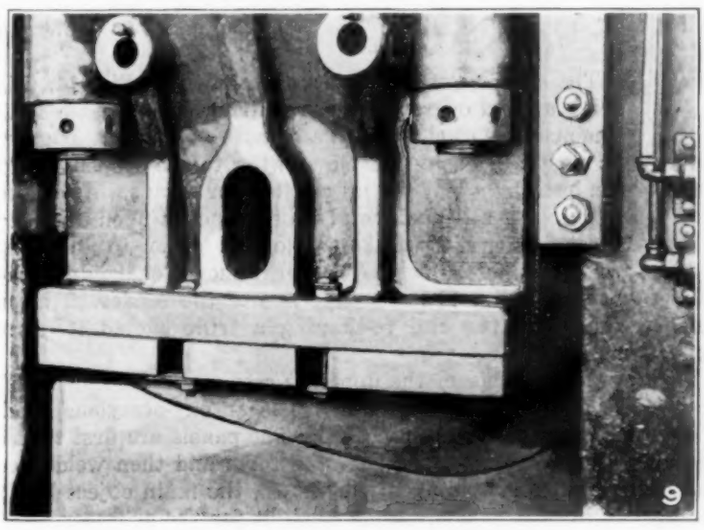


FIG. 9. THE DIES CLOSED

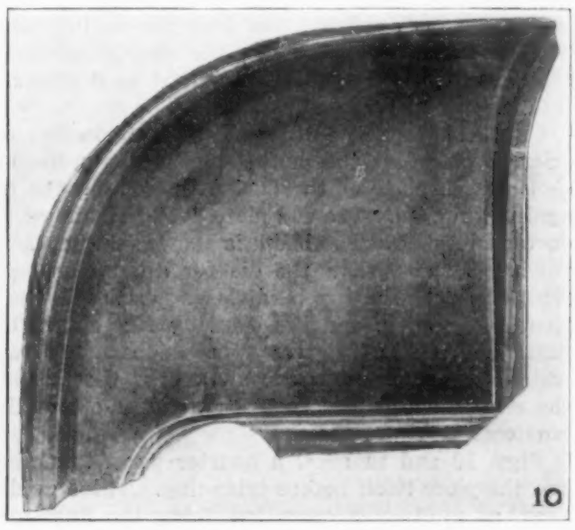


FIG. 10. THE PANEL BEFORE TRIMMING

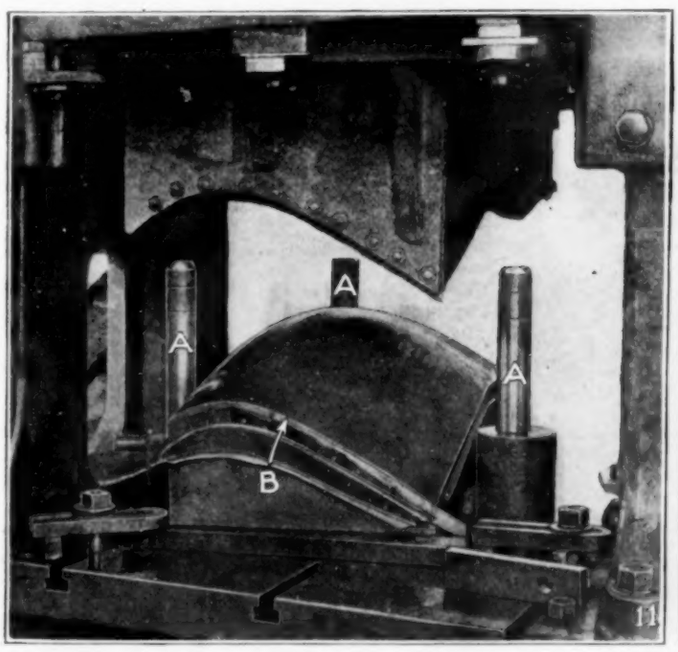


FIG. 11. THE FORMING AND TRIMMING DIE

FIG. 12. THE TRIMMED PANEL

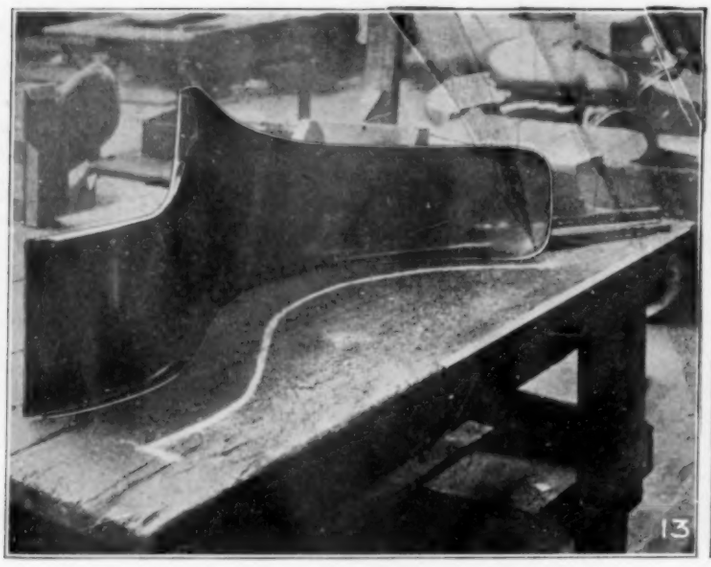


FIG. 13. INSPECTING AND STRAIGHTENING

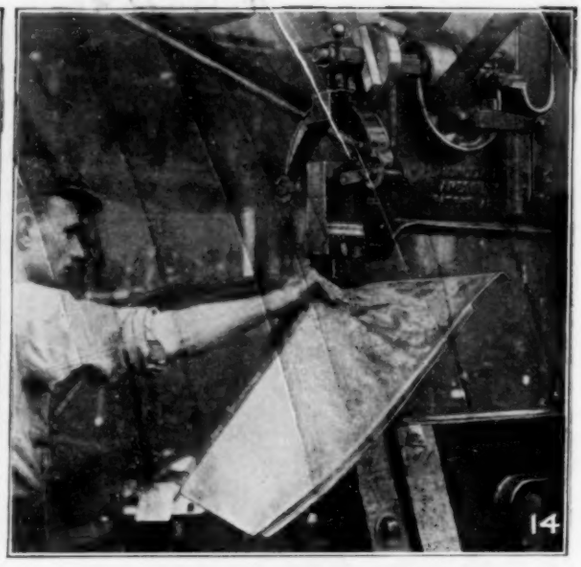


FIG. 14. THE BUMPING HAMMER

in position in Fig. 5 together with the die into which it mates. This view also shows the inserted plates at *A*, these taking the friction of the metal as it draws down into the die.

Fig. 6 shows the die closed and the meeting of the friction pieces at the end. It also shows the use of *C*-clamps in place of the hooks for holding the die up against the ram. The end piece at *A* is fastened by the dovetail block *B*. The blank is shown in Fig. 7.

Figs. 8 and 9 show the die for a curved wing of a fender in both the open and closed positions. The position of the sheet and the drawing ribs shown on the punch at *A*, Fig. 8, gives a good idea of the way in which these dies are made and shows the punch with the ribs which help to keep the wrinkles out of the flat portions.

Figs. 10 and 11 show a quarter panel trimming die and the piece itself before trimming. Three guides are used, as at *A*, this operation doing the final forming and also trimming the edge as shown at *B*. By allowing extra metal, a clean edge is secured, as all tendency to wrinkle can be confined to the portion which is trimmed off, as can be seen. The trimmed panel is shown in Fig. 12.

The shaping of the fenders is shown in Fig. 14, this being a hand operation and requiring considerable skill. The machine used is called a bumping hammer. It gives an elastic or cushioned blow owing to the suspension of the head by a leaf spring and leather straps. As in the working of all sheet metal, much depends upon knowing exactly where to strike a blow in order to take out wrinkles and bulges. The form shown chalked on the bench in Fig. 14 is the side line of the fender. This is for inspecting and re-shaping a trifle should it prove necessary.

The joining of the upper or crown part of the fender to the apron or quarter panel is an oxy-acetylene welding job as shown in Fig. 15. The panels are first tacked in position with the use of a form and then welded on the simple welding bench shown, the main object being to have it at a convenient height for the operator.

Fig. 16 shows how the fenders are fitted to a sample frame and incidentally shows the type of fender brace used by some makers.

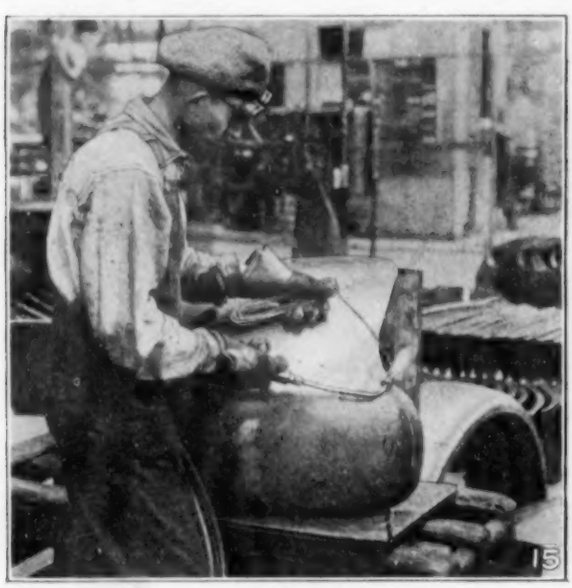


FIG. 15. WELDING THE SEAMS

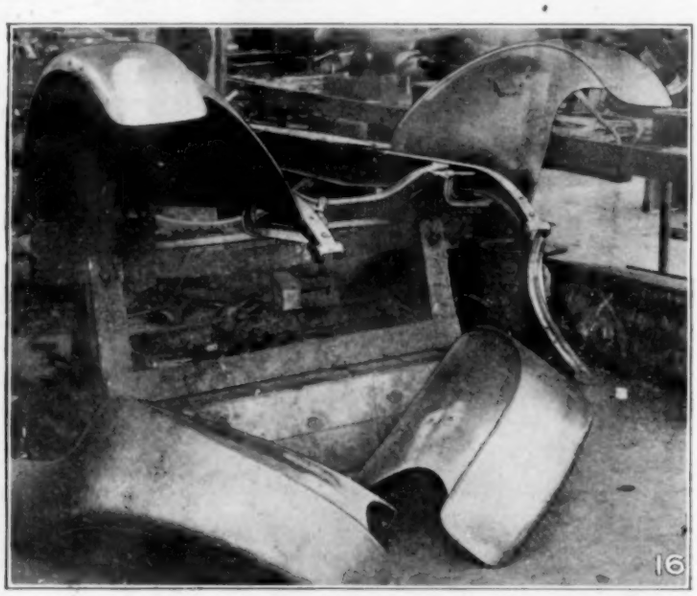


FIG. 16. TESTING FENDERS ON A FRAME

A New Method of Case-Hardening Steel*

By WM. J. MERTEN
Metallurgical Engineer, Westinghouse Electric and Manufacturing Co.

Here is a recent development in the carburizing of steel, in the form of a method that promises much for the future. Greater speed, uniformity and depth than now obtainable are claimed for the process described. The factors governing case-hardening and the methods in use at present for performing it are reviewed in the first part of the article.

IRON and low carbon steels absorb carbon from so-called carburizers very readily when in contact with these carbonaceous materials at temperatures above the upper critical point (Ac_2). The quantity of carbon absorbed depends upon:

1. The temperature or degree of heat above the Ac_2 point of the steel; or, in other words, the higher the temperature the faster and deeper the penetration of the carbon. This temperature is high enough to change the iron to gamma iron, which is capable of forming a solid solution with carbon or cementite. Beta and alpha iron do not absorb carbon to an appreciable extent.

2. The character of the carburizer is a very important factor in the successful conductance of case-hardening. Elementary carbon as such is only of secondary importance. Oxygen and nitrogen compounds, which are added or are naturally present in the so-called energizers that form carbonaceous compounds with solid carbon, are necessary to generate nascent gaseous carburizing mixtures of carbon monoxide and cyanogen gas (CO and CN). Flourishing industries are built up on the production of these carburizing materials and energizers.

3. The percentage of carbon present in the steel to be case-hardened has also a marked influence upon the affinity of the material for more carbon up to saturation. More specificially, a low carbon steel absorbs faster than high carbon steel.

4. The presence of chromium, tungsten, or manganese accelerates the absorption of carbon, since these elements form double carbides with iron. Nickel and silicon, however, retard the absorption. The fact that they form solid solutions with iron may be the cause for this retardation.

From the statement under paragraph (2), which states the necessity of nascent carbonaceous gas formation for penetration and absorption of carbon, it is readily conceivable that, if a properly heated piece of steel be brought into contact with pure nascent gas continuously generated in a separate unit or chamber and preferably under pressure, the conditions for case penetration would approach the ideal. A process of this type is the one presented in this paper; but before giving the description a survey of the processes now in vogue with their disadvantages and deficiencies seems to be appropriate.

Present-Day Methods of Case-Hardening

First Method. The most general and commonly used method of case-hardening is conducted by packing steel parts in a metal box filled with carburizing materials, and then firing the tightly closed box and contents at a sufficiently high temperature for a length of time adequate to give the desired depth of case. This process is quite simple and assures fair success if properly conducted in accordance with a prescribed procedure, experimentally determined to give certain definite results under definite and specific conditions. The disadvantages of the process are:

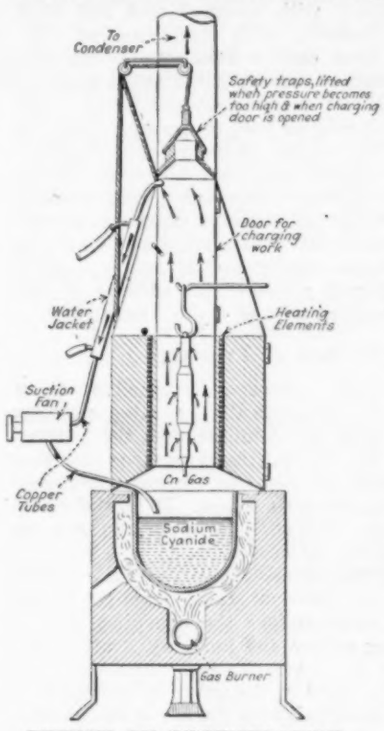
1. Uncertainty of obtaining the proper reaction within the closed box.

2. Difficulty in duplication of results as pre-determined, because of non-uniformity of carburizers.

3. Long time exposure of the steel to a heat not well controllable produces a questionable structural condition.

4. High cost of operation because of the inefficiency of the heating method, the cost of the boxes and the rapid deterioration of them by oxidation or scaling.

Second Method. Another method of case-hardening is performed by immersing the steel article in a cyanide bath heated to about 860 deg. C. (1,580 deg. F.). This process is convenient and effective on small articles only and where the depth of the case required is not more than 0.005 in. to 0.015 in., or where mere surface hardening is wanted. This is a fast case-forming method, and from 10 to 15 minutes gives the desired depth. The outstanding disadvantage of this process is that no uniform case can be produced. The parts deep in the melted bath do not get the same depth of penetration as the parts near the surface. The evolution of the cyanide gases at or near the surface favors the penetration, and it is hardly feasible to have pots with a large enough surface area to take care of the case-hardening work of an entire plant.



SKETCH OF REGENERATIVE CYANOGEN-GAS CARBURIZING FURNACE

Third Method. The third method consists of dipping of a cherry red piece of steel or tool into a container of a powdered cyanide salt, such as potassium cyanide, sodium cyanide or ferro- and ferri-cyanides; or sprinkling the powdered salt of these cyanides on the red hot steel surface and putting the steel back into the fire again. The case-hardening produced in this way is but a very superficial one, and resistance to excessive wear cannot be expected.

Fourth Method. In the fourth method the carburizing gases are passed over a piece of steel heated in a retort. This process is applicable to parts that are intricate in design.

All these processes serve the needs of the different industries more or less satisfactorily. Box case-hardening is at best dirty, wasteful and unsatisfactory in a number of instances. Case cyaniding by firing in fused cyanide salt is inefficient, unreliable, dangerous and costly. Retort case-hardening with carbonaceous gases is a step in the right direction, but it leaves something to be desired on account of the selection of the carbonaceous gases and the method of application.

Cyanogen Gas as a Carburizer

The process to be discussed next, although still in the experimental stage, owing to radical changes in the principle employed, appears to present opportunities for efficiency, preservation of the product, simplicity of operation, assurance of uniformity and duplication of results,

*Presented before the Pittsburgh Chapter, Heat-Treaters Research Society, Sept. 9, 1920.

speed of operation, reasonable cost, and wide range of utility. We may call this process a regenerated cyanogen gas case-hardening.

It has long been recognized that the most effective carburizing gas is cyanogen (CN), that by it a case can be produced more rapidly, with greater uniformity, and with deeper penetration than one produced by carbon monoxide (CO); but the highly poisonous character of the substance has been a serious objection to its use, and the tendency is to wastefully lead the gas to the stack and out of harm's way, instead of controlling it to get maximum efficiency.

To case-harden steel and iron alloy articles in a stream of cyanogen gas evolved from a container filled with an alkali cyanide salt, heated by electrical energy or other means to accomplish vaporization or boiling of the salt, is the principle upon which the new process is based. The articles or materials to be processed are independently heated out of contact with the fused cyanide salt. The advantage of this will readily be appreciated on recalling the statements made regarding the fact that case-hardening is produced by contact with gaseous and not with solid carbon, and more especially with cyanogen gas. The depth of penetration is then only a function of the uniformity of the temperature of the article treated and the duration of treatment. Nascent cyanogen gas has a speed of penetration of four or five times that of carbon monoxide.

The furnace shown in the sketch embodies the regenerative principle, since the excess gases not absorbed by the steel are forced under pressure into the fused cyanide bath, are reheated, causing a vigorous stirring of the bath and a lively evolution of cyanogen gas. The gas is thus produced with more energy and in larger quantities, and it more vigorously attacks the surface of the steel, thus causing an accelerated and deeper penetration.

Regenerative Type of Furnace

This regenerative type of furnace is a means of using the rather expensive salt economically, as the nitrogen gas on returning to the bath will combine with the sodium, and a carbon supply in some cheap form such as charcoal can be added to the liquid as required, thereby retaining the original amount of cyanide salt intact. It is, therefore, obvious that this process may compete with the present box or packing carburizing processes.

To prevent the poisonous gases, which are under pressure, it should be recalled, from escaping into the room, the suction fan is shut down before the charging door is opened, a bell ventilating device for inducing draft is arranged so as to open the bell when the fan stops and prior to opening the door. The speed of the pump or blower is to be regulated so as to cause the desired degree of circulation. Parts of the pump or suction fan wherever possible should be of non-ferrous metals, such as copper basic alloys or hard copper. Water cooling jackets or other protective methods are to be employed for the return flues containing hot gases, and the nozzle end of the flue must be of hard copper, monel metal or other non-ferrous alloy with a high melting point.

Sodium cyanide melts at 600 deg. C. (1,112 deg. F.) and boils at 800 deg. C. (1,472 deg. F.). The temperature of the pot must therefore be not less than 800 deg. C., and to effectively absorb the gas the steel is at a temperature above AC_3, or about 900 deg. C. (1,650 deg. F.).

The furnace illustrated in the sketch is designed especially for the processing of shafts, but a slight modification of the upper or steel heating chamber will adapt it to a variety of work. Grates of nichrome metal with knife-edge grate bars for supporting the work can be employed.

The advantages of this process are the following:

1. Temperature control is more perfect, since a pyrometer is inserted directly in the heating chamber;

2. It gives a finer, more uniform, and deeper case than any other process and requires less time, and is therefore cheaper;

3. It eliminates the use and storage of carburizers and carburizing boxes.

The efficiency of cyanogen gas for case hardening has never been fully appreciated, nor has it been fully obtained, since during previous tests the temperature was at or below the boiling point of sodium cyanogen (1,465 deg. F.), which is considerably below the AC_3 point of the steel. But, even in this unfavorable condition an exceptionally high speed of penetration has been noted by different writers on the subject.

It should be noted that, while some of the less important features of this process are still speculative in character because of the experimental stage of the development, the method is based upon well known principles and the conclusions have been drawn from a careful study of general case-hardening practice.

The Turn of the Tide

By Entropy

For fifty years preceding 1914 the man who wanted a job met competition while the employer could pick, choose and bargain. There were always men whose necessities caused them to accept less than the going wage. For the five years succeeding 1914 the reverse was true. Employers competed with each other and workmen received more in dollars and cents. This apparent reversal of position was not altogether a profit for employees, for the very fact that they had the upper hand compelled their employers to pass along the burden to the general public, or as it has been so well put, "the ultimate consumer." Inasmuch as the ultimate consumer is made up very largely of wage earners, to that extent they paid their own increases in income. The only people badly hit were salaried men and those few who were unable to shift quickly into lines of business in which there was a war profit.

During the fifty years referred to there was a great deal of complaint from employees that advantage of them was being taken, and that their necessities made them victims to their employers. During the five years there has been at least as much wailing and gnashing of teeth as through the whole fifty years, and yet it is not likely that there has been as much monetary loss to employers as there was previously to employees. The trouble seems to be complicated with non-financial features; that is, in addition to the problem of the proper distribution of the earnings of industry between labor and the directors of capital, there is the problem of control.

Out of any body of men there will always be a few who want to "run things." They are not necessarily born executives, but they think they are. If they are not, and yet get in control, they are a serious drawback in any business no matter whether they are in the ranks of wage earners or in the office of the company. Not very many years ago the larger part of the business houses had single names at their heads. Then there were partnerships of two people only. In the directory of my home town for the year 1842 I find that there were 139 people doing business under single names, 38 partnerships of two people, almost always brothers, and only two partnerships of three people. The only corporations at that time were railroads, banks and fire insurance companies. These were all in businesses which are today more often incorporated than not. Since that time there has been a growing tendency for men to operate businesses who do not own the money which they manage. At that time if a man needed more money in his business than he himself possessed he went out and borrowed it, of a bank if he could not get it from his friends, but he was very shy about letting anyone know the secrets of his business, either financial or relating to his designs or

methods of manufacture. Today men are just as shy about putting all their money into one business. The far-famed advice of David Harum, if it was his, to put all your eggs in one basket and then watch that basket, is not so often followed as quoted. Men invest in other than the business they are in and trust their money to the management of a hired man exactly as they trust the running of a lathe to a hired man. He sometimes is on a piecework basis, sometimes on a bonus plan and sometimes on a straight salary, but as a usual thing he sits with the board of directors, is one of them in fact, and oftentime is thought by the public to *be* the company. He is really a hired man who has gone a step further than the men whom he in turn hires.

By this process of evolution the old problem of labor and capital has become a problem of the work of management versus the labor of production and the question of proper division of the product of both is not altogether impossible of solution. There still remains the problem as to whether these two kinds of labor shall co-operate or antagonize. There is an old saying that it takes two to make a fight, which is true enough, but it takes only one to start a massacre. If the man into whose hands capital is entrusted wants to do so, he can at times take a very great advantage of all the people with whom he deals, but not all at the same time. He can use his capital to buy at bankrupt sales and he can use it to make such sales possible; he can use it to extort high prices from customers, but not usually at the same time that he is getting favorable purchases; he can, usually about the same time he is making advantageous purchases get his labor for less than the market rates if he is so disposed. He can do all these things at different times but he has to realize that the worm nearly always turns and he is realizing more and more that it is not only good ethics, but good business, to live and let live. He realizes that if he crowds the people from whom he purchases supplies too much, they may go to the wall and he may have to buy his goods in the open market after all. He realizes that if the people from whom he buys when they are in need survive, they will take reprisals when their turn to come on top occurs. He is beginning to realize that labor is likely to do the same thing, because that is what it has done in the last five years.

A Serious Difficulty

There is though, a serious difficulty about living and letting live as applied to employees, in that the average employee is not educated up to the standard that permits him to see this policy in its true light. The important thing to a laborer, or to a semi-skilled operative, is money in this week's pay envelope. He does not seem to think in terms of the next ten or twenty years. For that reason it is difficult to lay out long programs based on stabilized labor conditions. Education in the affairs of the world is necessary, and best of all, has begun. There is many times as great interest taken today by the plain people of the country in events outside their own sphere as there was before the war. Any street car is likely to be the scene of a sharp debate on National issues, where five years ago nothing outside the town except baseball scores was mentioned. This is a hopeful sign. When men begin to question whether their home hardware dealer is to blame for the scarcity of paint brushes, or whether it is due to business conditions in Russia, there is hope that they will take an equally intelligent interest in the ability of the shop in which they work to pay large wages, or work short hours or provide the comfortable working conditions which prevail in some other shop more favored by circumstances.

The great danger, just at this time when men are uneasy and are doubting their own as well as others' judgment, is that their employers may take advantage of the turn of the tide to wreak vengeance. Anyone who has that feeling might well stop to consider whether the workmen themselves had any part in the increases in their wages or whether they were simply carried along by conditions for which they can claim no credit, and for the results of which they were not to blame. The law of supply and demand has never been out of operation for very long at a time. When workers were scarce employers were bidding against each other. When the unions made demands for higher wages or shorter work day units they were rather extensively granted because the work which the men could do was so profitable to their employers that they could afford to put their pride in their pockets. In some instances they made bargains with their men which they wish they had not. Some of them even went so far as to make their shops closed shops for immediate profit. Now they feel that they threw away a part of their rightful management by so doing. It is especially easy for such managers to feel that their chance to rescind such agreements is soon coming. So long as these agreements are re-made in accordance with the terms of the original agreement, there can be no adverse criticism.

Tendency to Admit Employees to Councils

There will undoubtedly be an increased tendency to admit employees to the councils of the firm, and if it is done with the aid of simple, frank and complete information as to the business standing of the company there should be an increased stability of employment, which in itself may readily make a profit larger than the usual dividends. In the course of bringing such an arrangement into good running order there is great danger of misunderstanding. The formation of a shop committee in itself tends to make less important the work of the walking delegate who wants his job just as badly as anyone else. If he can make the employees suspicious that the statements concerning the firm's affairs are not correct he is likely to do so. The only answer is to make them so clear and so easily verified that he can be answered at once and convincingly. Fighting is going to do employers little good. Education of the employee can accomplish infinitely more. We should look on men who decline to take good jobs as men who are mistaken, just as we look on the firm that will not buy our product as someone to be sold and not antagonized. There is very little difference. The prospective customer is studied and we send one salesman after another to see him to discover his method of reasoning before we give him up.

If we have a superintendent or a foreman who cannot get along with the men, or if we have an employment manager who cannot get men who will stick to the job, or if the men all become antagonistic to the firm we should use the same sales methods and find out how we can get a suitable body of steady workers. It is possible that we do not understand them any better than they understand us.

Programs of Apprenticeship and Special Training In Representative Corporations

By J.V.L. Morris

THE Carnegie Steel Co. in its three principal plants and central office in Pittsburgh offers some interesting developments of the training idea in industry. An apprentice school has been in operation for seven years and a salesmen's school is also well established. Out of the technical training for the latter has grown the idea of the third and perhaps most interesting type—the works school.

VII. The Carnegie Steel Co., Pittsburgh, Pa.

This is the first article of the series that takes up the subject of employee training in the steel-production industry. The tendency in the plant under consideration seems to be to instruct in the problems peculiar to the industry all those who work with their brains, and others who seem capable of advancement.

(Part VI appeared in the Dec. 9 issue.)

SALESMEN'S SCHOOL.—As regards the salesmen's school, it should be remarked at the outset that it is not the policy of the company to take on inexperienced young men who think that they want to become salesmen, give them a course of training and send them into the field as their sales representatives. Those accepted for the training course are already successful salesmen. The plan of the course is to give two months to the concentrated study of the technical elements of steel, coupled with inspections and observations throughout the mills. It is thus expected that the salesman under training will arrive at a point where he knows steel sufficiently well to be of service to the company's customers and, through understanding their needs, to present the merits of his product.

For this purpose classes of approximately eight salesmen are formed four times a year, thus providing for training thirty to thirty-five men each year. Three men, the director of this work and two assistants, all first-class salesmen as well as technical experts in regard to the product sold, constitute the faculty, which by lectures and plant inspections provides the instruction.

WORKS SCHOOL.—The fact that the material developed for the lectures in the salesmen's school would be equally valuable for training all the personnel of the company whose intelligence is in any way enlisted in maintaining or improving the quality of the product, has gradually grown in the minds of the management. Consequently, this material has been compiled in a 600-page book written in layman's rather than in technical phras-

FIG. 35. DRAFTING CLASS IN APPRENTICE SCHOOL

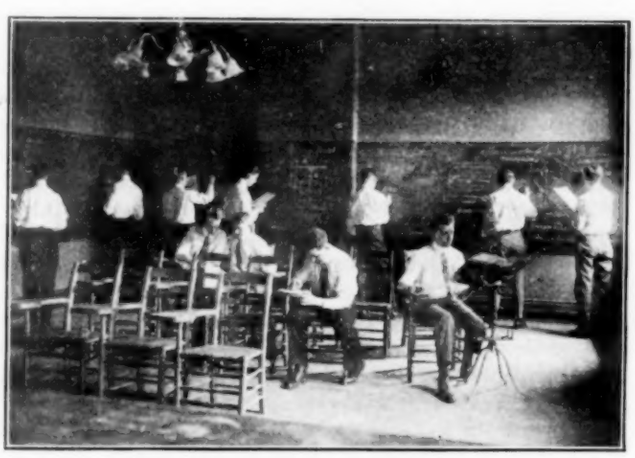


FIG. 36. APPRENTICES IN SHOP-PROBLEMS CLASS

ing. It has been put into an attractive and durable format and is to be sold to all employees who desire it at a nominal sum—less than half that which the management finds it necessary to charge the general public.

An able educator has been engaged to open classes in each of the three major plants of the company, in which this book will be used as a text. Attendance at these classes will be voluntary, although they will be held on the company's time and composed usually of men selected by the foremen as of a superior sort in intelligence. It is possible that ultimately the classes will include all, from the superintendents down to the brighter apprentices, who are ambitious and capable of advancement.

To start the experiment, these classes will meet but one hour a week during a period of twenty-four months, which is expected to be the time required to cover the course as now projected. A considerable amount of outside reading will be expected, for which ample facilities are available—as might be expected in Carnegie plants—in the generously provisioned metallurgical libraries provided for each of the plants.

The course as projected follows:

CARNEGIE STEEL COMPANY
DUQUESNE WORKS APPRENTICE SCHOOL
SHOP PROBLEMS WORK RECORD

Term No. _____
Intelligence _____
Attitude _____
Workmanship _____
Speed _____
Total rating _____

NAME _____ START _____
FINISH _____
CHECK NO. _____ DEPT. _____ TOTAL _____ Mo. _____

JOB	PROBLEM NO. 1 2 3 4 5 6 7 8 9 10	TIME RECORD	Total hours	Workmanship	Attitude (Weekly)	REMARKS

FIG. 34

CARNEGIE STEEL COMPANY
DUQUESNE WORKS APPRENTICE SCHOOL
MECHANICAL DRAWING WORK RECORD

Term No. _____
Intelligence _____
Attitude _____
Workmanship _____
Speed _____
Total rating _____

NAME _____ INST. NO. _____ START _____
FINISH _____
CHECK NO. _____ DEPT. _____ BOARD NO. _____ TOTAL _____ Mo. _____

DRAWING JOB NO.	Time Record	Total hours	Workmanship	Attitude (Weekly)	Remarks
BLUEPRINT READING Drg. No.					

FIG. 37

FIG. 34. FORM FOR RECORDING SHOP WORK DONE BY APPRENTICE
FIG. 37. FORM FOR RECORDING WORK IN DRAWING

FIRST PERIOD—STUDY OF RAW MATERIALS—4 MONTHS

1. Preparatory study, physics and chemistry, 1 month.
2. Refractories, 1 week.
3. Ores of iron, 1 week.
4. Fuels and the manufacture of coke, 2 months.
5. Fluxes and slags, 2 weeks.

SECOND PERIOD—STUDY OF THE BLAST FURNACE—5 MONTHS

1. Composition and constitution of pig iron.
2. Principles of the process and equipment for the manufacture of pig iron.
3. Construction of the blast furnace.
4. Blast furnace accessories.
5. Equipment for handling raw materials.
6. Operating the furnace.
7. Chemical reactions.

THIRD PERIOD—THE MAKING OF STEEL—7 MONTHS

1. Consideration of the ferrous products.
2. The bessemer process, 6 weeks.
3. The basic open-hearth process, 3 months.
4. The electric process, 1 month.
5. The duplex and triplex processes, 1 week.
6. The chemical testing of steel, 3 weeks.
7. The physical testing of steel, 2 weeks.

FOURTH PERIOD—THE SHAPING OF STEEL—6 MONTHS

1. Methods of shaping steel.
2. Essentials of rolling mill construction and operation.
3. Ingots and their defects.
4. The soaking pit.
5. The rolling of blooms and slabs.
6. The rolling of billets.
7. Rolling sheet bars and skelp.
8. Defects in the semi-finished product.
9. Rolling of sheared plates.
10. Rolling of universal mill plates.
11. Rolling of large sections.
12. The hot rolling of strip.
13. Merchant mills.
14. The rolling of circular shapes.
15. Forging of circular shapes.
16. Forging of axles, shafts, and similar shapes.

FIFTH PERIOD—THE CONSTITUTION, HEAT-TREATMENT AND COMPOSITION OF STEEL—2 MONTHS

1. The structure of plain steel.
2. Thermal critical points for plain steel.
3. The crystalline structure of steel.
4. Heat treatment of plain steel.
5. The composition of steel.

TOTAL—24 MONTHS.

APPRENTICESHIP SCHOOL.—To study the apprenticeship provided by this company the Duquesne Works were visted. Here apprenticeship has been in operation since the establishment of the works, although supplementary instruction in a corporation school has only been provided during the past seven years. There are now seventy apprentices, to whose instruction a supervisor gives his whole attention with the aid of six part-time assistants from the technical staff.

A larger variety of trades are recruited in this plant by apprenticeship than is the custom in many plants, as will be seen by the following summary of enrollment:

Armature winders	4	Masons	12
Blacksmiths	1	Painters	1
Machinists	38	Patternmakers (at present)	0
Boilermakers	7	Pipefitters	5
Carpenters	1	Roll turners	1
		Total	70

Twenty-two have been graduated during the past three years, thus at an average of a little over seven per year, while fifty-one have resigned, a mortality which may be accounted for to a considerable degree by the unsettlement of employment conditions attendant upon the late war.

CARNEGIE STEEL COMPANY
DUQUESNE WORKS APPRENTICE SCHOOL

APPRENTICE RECORD

Name _____ Check No. _____ Dept. _____

Date of birth _____ Height ____ ft. ____ in. Wt. ____ lbs. Nationality _____

Date left Public School _____ Last grade passed _____ Rating _____

Date of enrollment in Apprentice Course _____ Date of finish of Apprentice Course _____

Previous Practical Experience

Kind of Work	With Whom	Where	How long

Father's name and address _____

Father's business _____

Term No. Rate		Class	CLASS RECORD: Late	Absent	Attendance %	Intelligence	Attitude	Workmanship	Speed	Total	Average	SHOP RECORD: Attendance %	Intelligence	Attitude	Workmanship	Speed	Gen. Value	Total	Combined Rating	Remarks
1		Drawing																		
		Shop Prob.																		
2		Drawing																		
		Shop Prob.																		
3		Drawing																		
		Shop Prob.																		
4		Drawing																		
		Shop Prob.																		
5		Drawing																		
		Shop Prob.																		
6		Drawing																		
		Shop Prob.																		
7		Physics																		
		Shop Prob.																		
8		Iron & Steel																		
		Shop Prob.																		
		Averages																		

FIG. 38. FORM FOR KEEPING RECORD OF WHOLE PERIOD OF APPRENTICESHIP

The work which provides the experience for the apprentices, particularly for the machinists, but in general for all trades except those in the nature of a specialty, is largely provided through the repair and maintenance jobs always to be found in a large plant, these being of a varied nature, but fruitful in providing a broad general experience. To insure that these jobs will embrace all the oeprations to be expected of a trained worker in the trade being pursued, and to rate the quality of workmanship, intelligence, and general attitude displayed in performance, the supervisor records and keeps on file the form Fig. 34 for each six months of each boy's apprenticeship. It will be seen that this provides for a job number for the jobs or operations which have been performed, with the problems which have been selected as suitable to accompany the same. This form is mimeographed on letter-size paper and provides for weekly entries.

The supplementary instruction is for four hours a week on the company's time and is divided into two-hour periods, seven to nine in the morning for those on day shifts and five-thirty to seven-thirty in the evening for those who are on night duty. The classes run through the usual school year of ten months and continue throughout the four years of apprenticeship. The instruction provided is in drawing, a class being shown in Fig. 35, mathematics, and the science related to the industry and trade concerned, in which subjects the excellent books now published are utilized as texts. In Fig. 36 is shown a class studying shop problems.

The accompanying record blank for drawing jobs and blueprint reading, Fig. 37, shows the method of rating the progress in drafting and blueprint reading. It should be noted that as far as possible classes are differentiated according to trades. This permits the assignment of problems and drafting of a kind which will have definite utility in the trade which the apprentice is pursuing. Naturally, where the number in a trade is too small to warrant forming a class, the individuals concerned are placed in the class where the instruction will be most closely allied to the work of their respective trades.

The complete record of the apprentice throughout the four years of service is entered on the blank shown in Fig. 5. It will be seen that both class and shop records call for exact reports of attendance and estimates of intelligence, attitude, workmanship and speed, while in the shop record an additional rating on general value is called for. All these ratings are then averaged and provide the combined rating for each term.

NIGHT SCHOOL.—During the past winter the company has for the first time maintained a night school, in which there was an enrollment of 150. The school finished with 45 per cent of the enrollment, which compares favorably with most evening trade extension schools. This represents a fourth type of educational endeavor existing in the corporation, the importance of which type may be expected to increase with the expanding of facilities for instruction.

Helix Angle of Twist Drills

By BRUCE W. BENEDICT
Manager of Shop Laboratories, University of Illinois

The author concludes from his experiments that, with the present design of flute, the most efficient high-speed milled twist drill has a helix angle of 35 deg. and that a drill with this helix angle consumes less power and generally has greater endurance than drills of other helix angles.

THE commercial twist drill is a metal working tool of great merit. It is accurately and ruggedly made; it is uniform in quality; it has great endurance; and it is cheap. Among the many high-grade standard tools there are none which outrank the twist drill in those qualities that make for service. Drill manufacturers follow common practices in methods of production, in design, and in use of special steels, which results in a remarkably uniform product. It would be difficult to identify the manufacturers of most drills if their names were removed, and production would not suffer if drills were purchased indiscriminately from leading manufacturers. There are few better examples of standardization in industry. Since 1862, when the Morse Twist Drill Co. commenced the manufacture of twist drills as a regular product, there have been no radical changes in twist drill design. Methods of production during this period have undergone great change, and the development of steel used in drills can be characterized quite properly by the term "revolutionary." The drill of today is vastly superior as a metal removing tool to the one of 50 years ago, largely on account of the methods of producing it and the character of the steel employed in its construction. Details of design have not undergone an equivalent transformation for the reason that original shapes proved to be structurally sound, and the manufacturer, confronted with the demand for greater endurance, naturally subordinated questions of design to those of technical production. Drill manufacturers and independent investigators have conducted large numbers of tests, most of which were concerned with point angles, clearance angles, or with power and endurance factors. The element of design has not been overlooked, but it is apparent from a study of published data that investigators have reported less about design (especially that relating to helix angle) than about the other factors mentioned above.

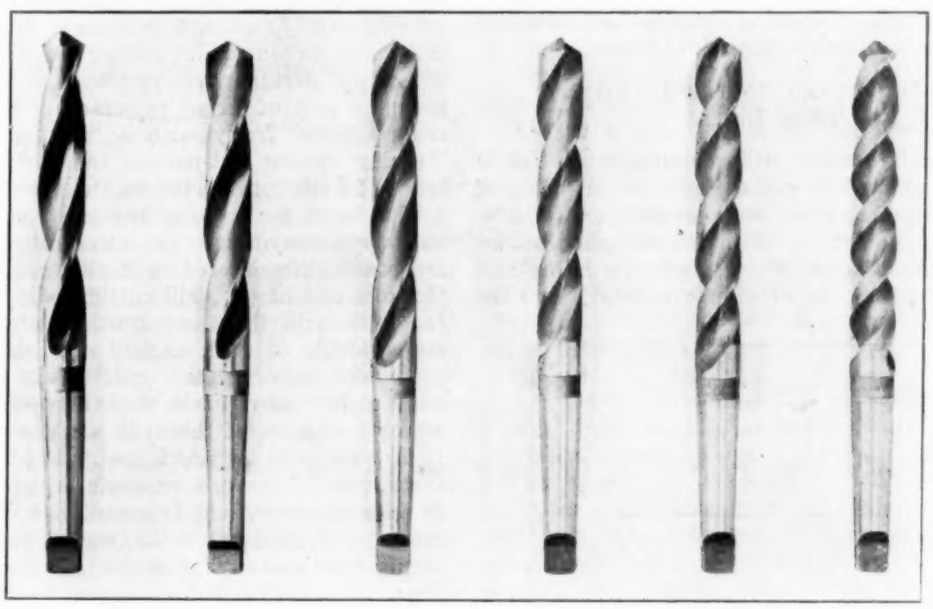


FIG. 1. GROUP OF TYPICAL TWIST DRILLS USED IN THE TEST

The twist drill is a cutting tool with the same function to perform as other metal-working tools, i.e., removing metal. In structure and method of application, it is unlike any other tool, and yet its action in the removal of metal is similar to that of other tools, notably lathe tools, which differ materially from twist drills in form and in methods of use. Although the mechanical processes of drilling and turning are quite dissimilar, the phenomenon involved in the actual separation of the chip from the metal undoubtedly is very much the same in both tools. If we keep this fact clearly before us, and at the same time make correct distinctions for various tool types, we have all the recorded experience with cutting tools to aid us in solving the problems surrounding the twist drill. In a machine tool, metal is removed by a combination of shearing, tension, and compressive stresses. The metal chip literally is torn from the main portion. This process comes within the broad meaning of the term "cutting," since a chip is severed from the original part. In reality it more nearly resembles the action of "tearing." If the tool was driven into the work as a wedge and a portion of the mass removed, the tool would perform an action in conformity with the true meaning of "cutting." While the cutting edge of the tool is wedge-shaped, one face of it only comes in contact with the metal, and the resulting action is not "cutting" in the strict meaning of the term. If metal could be severed with a sharp, thin tool in the same manner as cheese is cut, not only would we have a clear case of "cutting" but also the most economical method of performing this work. The blunt edged tool of 50 years ago, is almost the exact opposite of the tool just mentioned, both in shape and method of application. Its action in removing the chip is a violent tearing off of small particles, the

process resembling to some extent that of a long stroke punch press making half-holes in the edge of a very thick sheet. The efficiency of metal removal by this form of tool stands at the opposite extreme from that of the first mentioned tool. It is obvious that since a metal-working tool cannot be made like a cheese knife, and also that the ancient blunt form of cutting tool is hopelessly inefficient, there is some form of cutting tool between these extremes that will remove metal with the least power and at the least expense per unit of work done.

Unquestionably the most effective tool performs its work through an action resembling "cutting" more than "tearing," continuing the rather broad interpretation of these terms just employed. This condition is secured by increasing the keenness (acuteness) of the cutting edge to a degree that does not result in a sacrifice of endurance of the cutting edge. In general, all tool development is focussed on the cutting edge, the ultimate aim being to increase keenness without lowering durability. F. W. Taylor's classic experiments with lathe tools led to his adoption of standard shapes having "in each case the keenest cutting angle which is free from danger of spalling." He recommends the smallest degree of clearance in order to keep the top slope at a maximum, to mass the largest amount of steel near the point, for the transmission of heat. His findings, and the performance of the tools themselves are the most effective proof that keenness of cutting edge is an essential characteristic of the modern high-duty tool.

Use of Carbon and High-Speed Steel for Twist Drills

It is doubtful if twist drill manufacturers (as a whole) have attempted to utilize fully the principle of keenness in the cutting edge, to the extent permitted by the use of high-speed steel. With one exception known to the writer, manufacturers are producing high-speed twist drills of exactly, or of approximately, the same

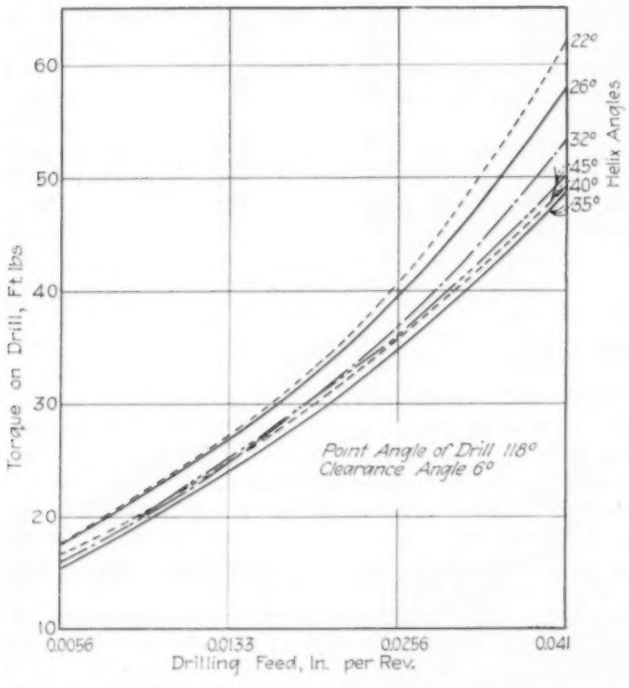


FIG. 2. POWER REQUIRED TO DRIVE 1-IN. DRILL OF VARIOUS HELIX ANGLES, AT VARIOUS FEEDS, IN CAST IRON

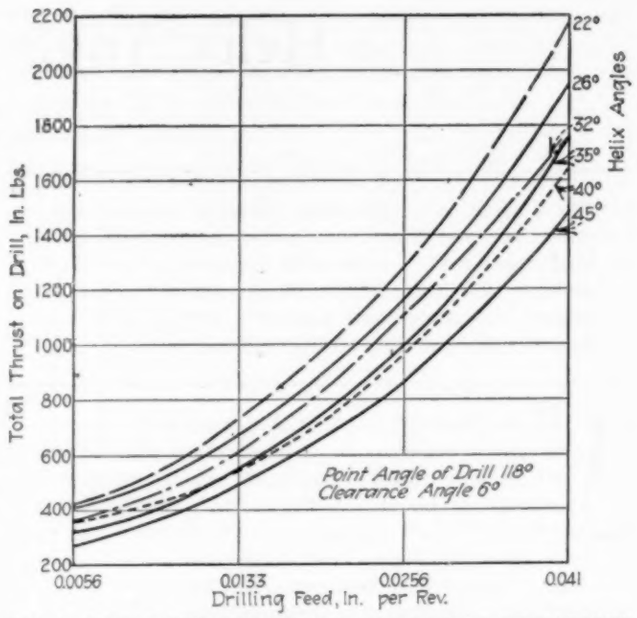


FIG. 3. TOTAL END THRUST ON 1-IN. DRILLS OF VARIOUS HELIX ANGLES, AT VARIOUS FEEDS, IN CAST IRON

cutting angle as established by them in the days of the carbon-steel drill. The superior hardness, strength, and edge retaining qualities of high-speed steel permit the use of a more acute cutting angle in drills than was possible with carbon steel. Taking full advantage of these factors the designer will produce a drill with maximum keenness and of great endurance. Such a drill will remove metal freely with a "cutting" rather than a "tearing" action and parallel the performance of other types of tools constructed on the same basic principles.

The basis for making the previous statement that manufacturers of twist drills generally have not utilized the possibilities offered by high-speed steel to increase the keenness of the drill cutting edge, is found in the fact that with the one exception noted by the writer, milled drills of both carbon and high-speed steel of prominent makers have identical helix angles. The helix angle as here used, is the angle between the cutting face at the periphery of the drill, and the axis of the drill. It is a measure by which keenness of cutting edge, or the degree of the cutting angle is determined. If twist drill development had followed that of lathe tools for instance, high-speed drills would have greater helix angles (and less cutting angles) than carbon-steel drills. Since this particular development in drill design is not necessarily a logical one for reasons that apply to lathe tools, it is obvious that this question can be determined only through special investigations. The subject has been investigated in some detail* at the University of Illinois, and the conclusion was definitely reached that milled high-speed steel drills with helix angles of 35 deg. remove a given amount of metal with less power and with less thrust on the points than drills of any other form. Equal or superior endurance also was shown by the drill named. Results of the investigations proved that a close agreement existed between theoretical considerations and shop performance.

Helix angles of milled drills made by the leading manufacturers vary between 20 and 26 deg. at the point, although one company markets a special drill having an angle of 32 deg. at the point. With the latter exception,

*Reported in Bulletin No. 103, Engineering Experiment Station.

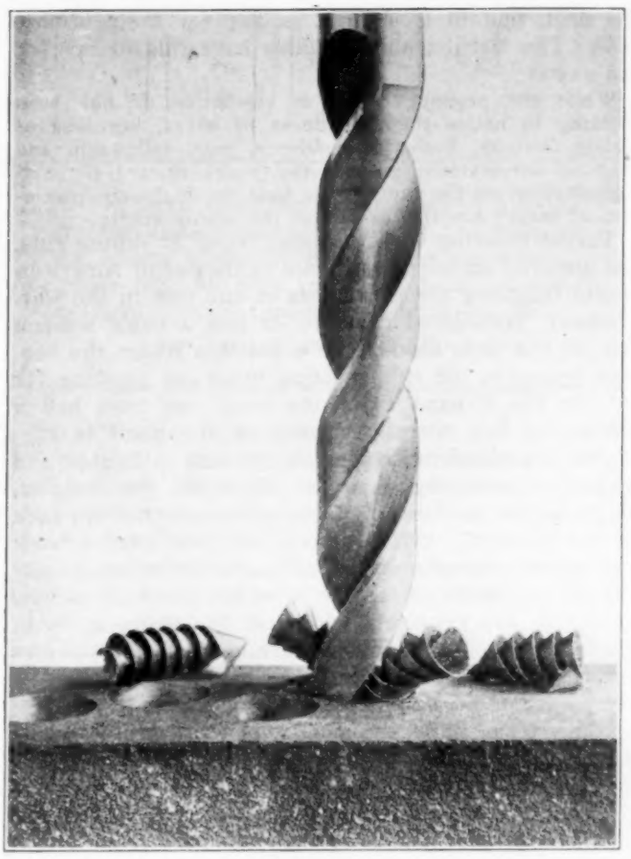


FIG. 4. DRILL OF 35-DEG. HELIX ANGLE CUTTING SOFT CAST IRON

the majority of milled drills, of both high-speed and carbon steels, have helix angles of either 22 or 26 deg. In many of these, the helix angle is decreased gradually toward the shank a total of 2 or 3 deg., so that cutting angles become increasingly blunt as the drills wear. Comparing these drills with the ideal form developed by the test, we observe that the cutting angles of the drills having 22- and 26-deg. helix angles are in excess of the former by 13 deg. and 9 deg. respectively. The meaning of this in terms of performance is shown hereafter.

The investigation included tests with milled drills having the following helix angles (in degrees): 10, 15, 22, 26, 32, 33, 34, 35, 36, 37, 38, 40, and 45. The regular drills used were stock drills purchased in the open market. The special drills used were made by a prominent manufacturer according to usual specifications except design. One-inch drills were used throughout. A group of typical drills is shown in Fig. 1. Most of the tests were made in cast iron, and the data presented here is from these records, since they are more complete than the observations made in steel to check the companion observations in cast iron.

The effect of changes in the helix angle on the power required to rotate the drill against the work and remove the chip is shown in Fig. 2. Limits of this article prevent an extended analysis of the results recorded on this diagram, but it is sufficient to note that the power consumption (represented by torque on the chart) of the 35-deg. helix angle drill, is less than that of drills of other helix angles. Power saving is greatest at heavy drilling rates; at a feed of 0.041 in. per revolution the power consumed by the 35-deg. helix angle drill is over 20 per cent less than the power consumed by the 22-deg. angle drill. The results of this test confirm the findings of investigators seeking to establish the relationship of cutting angle to power consumption in other types of tools. The 35-deg. helix angle drill removes metal more economically than drills of lesser helix angles because it has a more acute cutting angle and a cutting edge of greater keenness.

End thrust on the point of the drill is equivalent to the resistance of the metal to penetration of the cutting edges of the drill. Thrust decreases progressively as the helix angle increases; the unit changes being most marked at high drilling rates. See the diagram, Fig. 3. While thrust is less in drills of 45-deg. helix angle than in all others, a number of mechanical factors make it inadvisable to consider the use of helix angles above 35 degrees. At a drilling rate of 0.041 in. per revolution, the end thrust on the 35-deg. helix angle drill is approximately 20 per cent less than that on the drill of 22-deg. helix angle. It is clear that increasing the helix angle reduces the pressure on the cutting edges per unit of feed, resulting in less friction and heat.

Tests for endurance demonstrated the fact that the drill with 35-deg. helix angle would retain its cutting edge equally well or better than drills with helix angles of 22 and 26 deg., under usual drilling conditions. In fact the endurance record of the 35-deg. angle drill was generally superior to that of drills with lesser helix angles.

In drilling deep holes the 35-deg. angle drill proved to be more efficient in ejecting chips than the 22- and 26-deg. angle drills. No drill will eject all chips from a vertical hole, but the one with the smallest helical pitch of the flutes acts as the best conveyor. The shape and condition of the chip as it is removed retards or assists the process of ejection, and it is here that the 35-deg. angle drill proves superior to drills of lesser helix angles. A free curling chip to a large extent ejects itself. It is possible to obtain these even in cast iron with a correctly designed and properly ground drill. Note the work of the 35-deg. angle drill in cast iron as shown in Fig. 4.

The Best Clearance Angle

A clearance angle of 12 deg. is generally recommended by manufacturers. This is more than is necessary from the standpoint of clearance in drilling. With machine grinding a clearance of 6 deg. is sufficient. The inaccuracy of hand grinding requires more clearance than this, but hand grinding is a drill atrocity that should not be permitted. Metal removed from the heel of the drill reduces the volume of it available for the transmission of heat. Taylor recommends, as previously mentioned, the smallest clearance in order to keep the top rake of the tool at a maximum. One or the other elements must be sacrificed if sufficient metal for conducting heat is retained in the tool. A drill with a helix angle of 35 deg. and a clearance angle of 6 deg. has approximately the same quantity of metal in the cutting end,

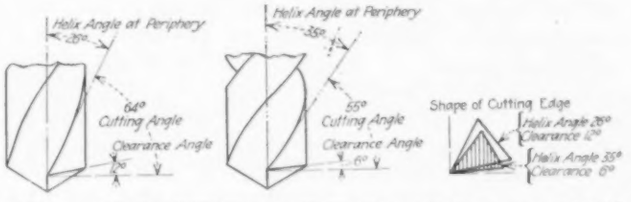


FIG. 5. COMPARISON OF CUTTING ANGLES OF USUAL AND PROPOSED DESIGNS OF DRILLS

as the 26-deg. angle drill with a clearance angle of 12 deg., as may be seen from the sketches in Fig. 5. Since less heat is produced by the 35-deg. angle drill in cutting, than by drills of the usual design, it is obvious that with virtually the same amount of metal at the point for the transmission of heat, this drill will possess superior qualities of endurance, depite its greater keenness of cutting edge.

Evidence produced by the investigation warrants the assumption that with present design of flute, the most efficient milled twist drill has a helix angle of 35 degrees. It is possible that development in the shape of the flute will lead to the employment of helix angles above 35 deg., and the attainment of still greater efficiencies. Such a development is logical, as high-speed steel presents great possibilities to the designer seeking to improve the cutting qualities of the twist drill.

Target Shooting as an Aid in Industry

By C. B. Lister

Promotion Section, E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del.

It has come to be an accepted fact that the employer's interest in his employees does not end when the whistle blows, but extends on down the street into their homes or, more directly, into their community life. Contented employees with that "group spirit" which places "our company," "our department," or "our division" in a class above the ordinary factory where men toil only to earn their daily bread, is the best insurance against the "57" varieties of labor troubles that are rearing their heads here, there and everywhere. Athletics with their intense group appeal have assumed a prominent place in the work of manufacturers directed toward the fostering of community interest, and athletic fields are now a common sight near many plants, large and small. These fields, which need not be elaborate, and the equipment required for the various teams, are cheap at any price provided they accomplish the desired result of cultivating an efficiency-increasing, all-together spirit. It is true that in the very small plants the personality of the manager and the limited number of employees make it possible to develop a kind of family atmosphere that is wholesome to the final degree but even there some form of competition with neighboring plants would inject spice into the work that would relieve it of its monotony.

There is also a general desire for some form of sport which will be open to all employees. Baseball, football and similar games excite great enthusiasm but only the favored few, men in the prime of life and with particular ability or "beef," can actually participate and get the benefit of team training, and of the steadiness of hand, keenness of eye, and quickness of mind that come from taking part in the sport.

The Urbana Tool and Die Co., of Urbana, Ohio, and several plants in New England and the East have successfully adopted a sport which seems to fill all of the requirements. It can be enjoyed on as elaborate a scale as the size of the factory warrants; it promotes the keenest kind of team spirit; no matter how small the division or plant, it may boast of its prowess; women and girls quite frequently give the male members of the force a "run for their money," veterans of the shop, men too old to take part in baseball or football games, find a means for taking their part in upholding "our shop's" honor; while the young men, both those who usually occupy the bleachers and those who play on the field, find in it a sport calling for their utmost skill. The Urbana plant officials have this to say for the game:

> While the primary object is recreation, it has been pleasing to notice that steadiness of nerve, keenness of vision, fairness, honesty, confidence, good fellowship and pride in achievement are invariably the reward for consistent effort on the range. We have the highest appreciation of target practice as one of the manly sports.

Target shooting with the small bore, .22 calibre rifle, has assumed an important place in the list of American sports following the experience of our men in the war. Formerly considered as more or less a boy's weapon the .22 has been elevated to a position where the biggest figures in the rifle shooting game are boosting for it. At the Urbana Plant the employees have had a range for five years. A room in the plant is furnished the shooters free of charge and is lighted and heated at company expense. Expenses for targets, etc., are met by dues of 25 cents per month from each of the riflemen. Official shoots are held once a week and practice shoots on certain other evenings. Individual and team prizes are awarded for high scores, handicaps are given on a basis of the scores made in official shoots, and the men are divided into classes according to their ability, stress being laid on the development of new marksmen as well as on the reward of the veteran shots, the idea being to interest as many men as possible and so spread the team spirit throughout the plant. Matches are held from time to time with teams from other plants and from surrounding clubs. Luncheons following these matches are the means of forming "friendly relations of beneficial and lasting endurance," to quote R. C. McDonald of the Urbana Co.

Rifle shooting as a sport has the added advantage that it is nationally recognized. The plant baseball star may be well known in the home town but he has little chance of ever receiving notice outside of his immediate locality. The small bore rifle shooter, however, has the opportunity of securing national prominence without ever leaving his club range. The National Rifle Association which is, as its name implies, the national association of riflemen in this country, arranges matches for all its affiliated clubs and gives trophies and qualification medals for certain scores made in practice, publishes a bi-weekly magazine containing news of national interest to devotees of rifle shooting, and in other ways encourages the sport. Should ground be available for a military range, the N. R. A. will issue regular U. S. Army Springfield rifles and ammunition to clubs free of charge, or if there happens to be a Government range near the plant, the club members are privileged to use the range and will be furnished rifles and ammunition by the officer commanding. Small bore rifles may be purchased for a rifle team for less than the cost of a baseball outfit and they will not wear out after a season's use, nor after several seasons' use for that matter. The ammunition costs only a fraction of a cent a round and an evening of the keenest competition can be held for the price of a new baseball. The range can be installed at very little cost and is practically indestructible. The possibilities of this sport as a means of successfully promoting the much talked about and much sought after "community of interest" among employees and employers are unlimited, as it appeals to men in all grades and walks of life.

Shooting with the small bore rifle seems about to assume an important place in America's industrial life.

Early Traces of the Toothed Wheel—II

By H. H. MANCHESTER

This article takes up the development of gearing from the sixteenth century up to the time of Watt. Some of the illustrations shown seem to be more fanciful than real, but the simpler arrangements pictured were no doubt in practice.

(Part I was published last week.)

BEGINNING in the latter part of the sixteenth century, a number of books on machinery were produced which not only prove the growing importance of machines, but indicate the kinds of gearing in use at that time.

One of these books was by Jacques Besson, of Paris, the first edition of which was published in 1565. Among Besson's illustrations the most interesting cut, Fig. 6, shows two wheels in the same plane, the teeth of which are drawn to fit with fair exactness. This use of wheels in the same plane was very rare at the time, probably because it required too much pains to make the teeth fit. In this case the teeth and indentations are roughly semicircular, and the spurs on the wheels geared with the lantern are decidedly curved, an arrangement which seems to have been comparatively unusual.

From the viewpoint of gearing the most important engineering book of the sixteenth century was that by Ramelli, which was published in 1588. This book contains a number of engravings which show combinations of pinwheels and lanterns with worms, as well as a very few examples of fitted spur wheels.

In one case we see a combination of drum, rope drive, worm, pinwheel and lantern, employed to raise stone, Fig. 7. Here the teeth of the pinwheel are semicircular disks, while the screw of the worm is evidently formed by winding the thread around the shaft.

In another cut, Fig. 8, similar combinations of screws, spur wheels and lanterns are used to pump water, the power being furnished from a waterwheel.

Early Example of Gearing Set Obliquely

One of the earliest illustrations of gearing set obliquely, is in a design showing a waterwheel employed to raise water through the medium of three Archimedian screws, Fig. 9. The screws are necessarily inclined, and the lanterns at the tops meet obliquely the pinwheels which are on the same shaft as the waterwheel. In this case the rounds of the lanterns are very short, and

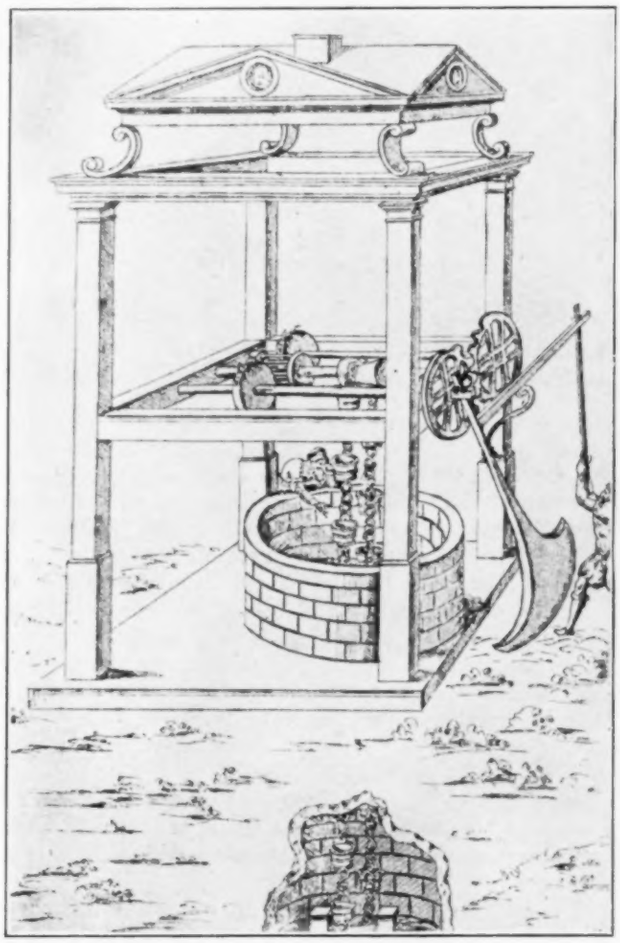


FIG. 6. BUCKET CONVEYOR SHOWING EARLY USE OF TWO WHEELS IN SAME PLANE

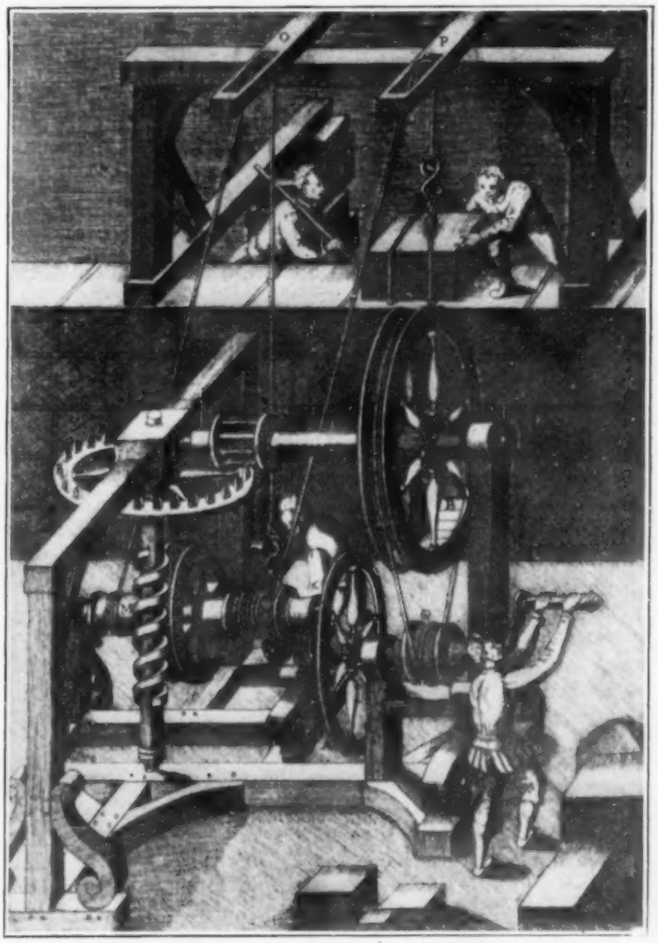
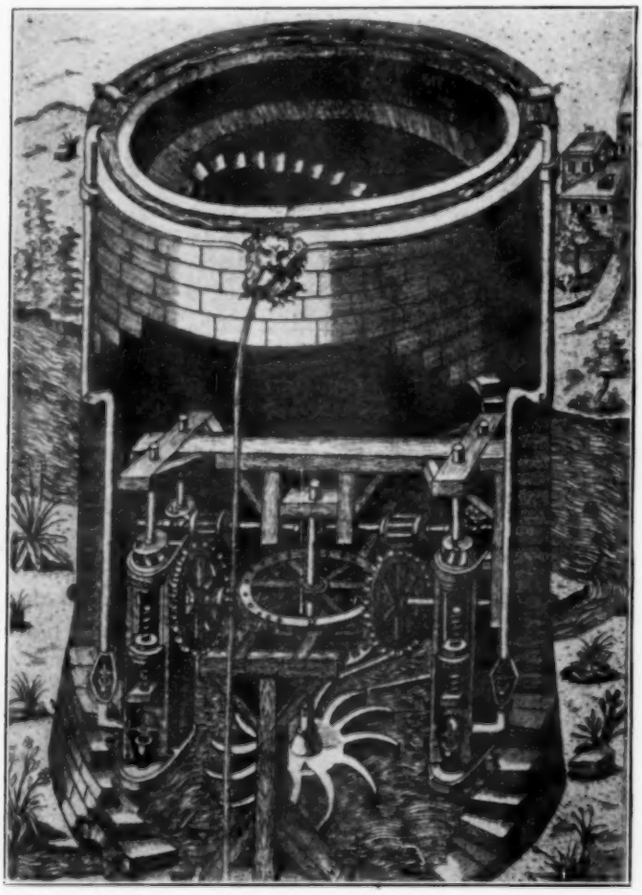


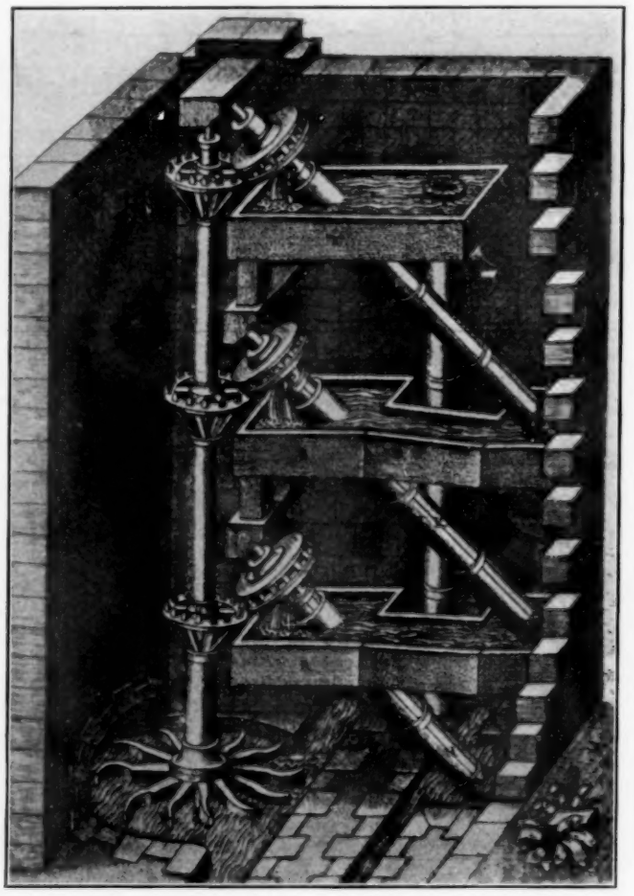
FIG. 7. COMBINATION OF DRUM, ROPE DRIVE, WORM AND LANTERN TO RAISE STONE

evidently required more exact construction than most rundles used at the time.

The pictures of wheels in the same plane with teeth made to fit number only two or three, which shows the rarity of such usage at the time. In the illustration, Fig. 10, the teeth are roughly semi-circular. The bucket shown could probably be raised by hand alone; therefore, this is probably one of Ramelli's designs of gearing which was never put into practice.

A design hitherto unnoted, shown in Fig. 11, is one where the cogs of the spur wheel fitted into a lantern where the rounds are arranged like spokes in the disk of the wheel. In order to strengthen the rounds, they were shortened by covering most of the face of the wheel. This design was made for a big bomb and stone throwing machine which was expected to rival the inefficient artillery of the period.





FIGS. 8 AND 9. TWO WATER-PUMPING SCHEMES

Beginning of Seventeenth Century

The practice in gearing at the beginning of the seventeenth century is illustrated in a work by Zonca published in 1607. This includes various examples of mills using toothed wheels and rundles, and a few with cams. More important are several designs showing the use of cog wheels in the same plane.

Zeising, in his various books which were published in the first quarter of the seventeenth century, includes a large number of designs for machines, but none of them show any gearing beyond what we have already mentioned. The same might also be said of Branca, whose book was published in 1629. He illustrates various lanterns combined with face and spur wheels, but the only improvement seems to be that the teeth on the face wheels were formed to some extent to fit the rounds in the lanterns.

In the many engravings included by Boeckler in his book printed in 1662, probably the only novel type of gearing seems to be the use of an oblique screw and cog wheel.

Second Half of the Seventeenth Century

In the second half of the seventeenth century the form of the cogs and teeth began to be considered principally by the mathematicians. This was probably due to the improvement in the clock, brought about by the application of the pendulum. Christian Huygens, to whom this important advance is ascribed, realized the necessity of the wheels in the clock running as smoothly as possible. He even took up, in an incomplete way, the evolution of the cycloid and traced the curve of evolutions; that is, the evolute. He favored this curve, at least theoretically, for the construction of the teeth on clock wheels, but it is not known that it was put to any general practical use for this purpose. Epicycloids were also discussed in a theoretical way by Desargues in 1674.

An important point to note is that the scientific and mathematical discussion of the shape of the teeth was in connection with exact instruments, such as the clock, rather than ordinary machinery.

The best insight into the ordinary usage in gearing at the end of the seventeenth century is afforded by the work of Mandey and Moxon, published in 1696. This includes a brief chapter on epicycloids, and one entitled

"Of the Length and Disposition of the Teeth of Wheels." The most interesting chapter, however, is that headed "To Make Divers Kinds of Wheels Commonly Used in Engines." This includes a number of definitions, or descriptions of the different types of teeth, which show what were in use at the period. Some of these run in part:

DEFINITIONS OF GEARING

A toothed wheel is that whose periphery sticks out with little handles endued with the semicylindric form.

A fingered wheel is that whose periphery is garnisht with plain cylindrick small stakes.

A sharp-pointed wheel is that whose periphery is cut with little handles like the figure of the point of a sword.

A studded wheel is that in whose periphery little sphaeres or convex hemi-sphaeres are disposed.

A starred wheel is that whose circumference is furnisht with three-sided prismes.

A hilical or screw wheel is that in whose circumference chanellings or grooves are made, according to the quantity of the angle of the axis of the inclined wheel, whatsoever figure the same hath, which nevertheless are reduced to four kinds, semicylindrick, trigonal, trapezias, or unequal.

A hooked or crooked wheel is that which hath hooks disposed in its circumference.

Also wheels are named with respect to their figure—let the teeth be what they will: orbiculates, convex cylindric, concave cylindric, conic.

Note that all the kinds of teeth may be made not only in the periphery but also in one or both of the lateral superfices.

LITTLE IMPROVEMENT IN GEAR TEETH

Good evidence that but little improvement had been made in the teeth of wheels may be found in the several engineering books of Leupold, and especially in his general work on machines which was published in 1724. While he states here that the cogs of wheels must be made to fit as neatly as possible, he gives no definite principles for doing so, and implies that the whole subject was still left to the rule-of-thumb skill of the workman.

The bevel wheel is sometimes said to have been invented by Camus in 1572, though a simple form of it was suggested by Besson 180 years previously.

The first gear-cutting machine seems to have been invented by James Brindley. The construction of the machinery for Pattison and Clayton's new silk mill in Cheshire, England, had been given to a millwright by the name of Johnson. He got himself all tangled up on the job, which was in a fair way of being a complete failure. Brindley was an assistant in charge of part of the work, but, as he was not a full-fledged millwright, Johnson would not deign to ask his aid.

Finally, however, the proprietors took alarm and called in Brindley to help them out of the desperate situation. One of his first steps was to design a machine for gear cutting. In the words of Samuel Smiles, "In order that the tooth and pinion wheels should fit with perfect precision, he expressly invented machinery for their manufacture—a thing that had not before been invented—all such wheels having until then been cut by hand at great labor and cost. By means of this new machinery, as much work, and of a far better description, could be cut in a day as had before occupied at least a fortnight."

This device, though called a machine by Smiles, was probably one worked by hand rather than by water power; in fact, most such labor-saving inventions employed manual power long before they did steam or water.

In 1771 Kaestner showed a method of describing and applying the involute to the teeth of wheels. Soon afterward Professor Robinson attempted to use this curve in constructing the cogs of wheels for a mill near Edinburgh, but the result was, for one reason or another, very unsatisfactory.

One of the first practical applications of beveled gears seems to have been made in the cotton mills of Arkwright, and to have been introduced chiefly through his suggestion.

An even newer type of gearing was the sun and planet motion which was invented by William Murdock in 1782, to be used in Watt's rotary engine for changing the reciprocating to a circular motion. Watt himself said, "It has the singular property of going twice around for each stroke of the engine, and may be made

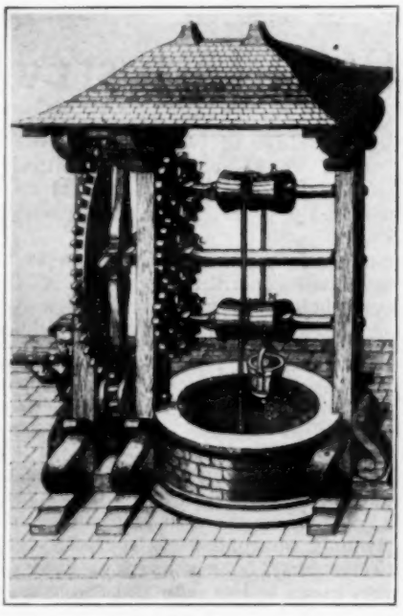


FIG. 10. A SIXTEENTH CENTURY USE OF GEARING

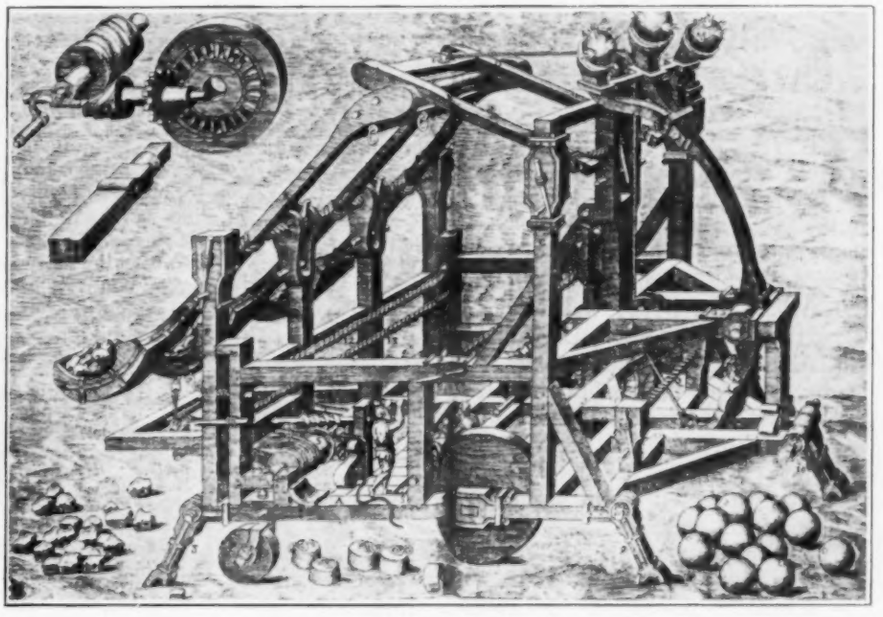


FIG. 11. A BIG BOMB AND STONE THROWING MACHINE OF THE EARLY SEVENTEENTH CENTURY

to go oftener around if required, without additional machinery."

The introduction of the steam engine, and especially of the rotary engine, created a demand for gearing able to stand a more rapid movement. This led to the practical use of iron instead of wood.

Perhaps the best appreciation of this is contained in Smiles' account of the steps toward this end taken by John Rennie (1784-1788): "The completion of the Albion Mills indeed marked an important stage in the history of mechanical improvements; and they may be said to have effected an entire revolution in millwork generally. Until then machinery had been constructed almost entirely of wood, and it was in consequence exceedingly clumsy, involving great friction and much waste of power. Mr. Smeaton had introduced an iron wheel at Carron in 1754 and afterward in a mill at Belper in Derbyshire—mere rough castings, imperfectly executed, and neither clipped nor filed in any particular form; and Mr. Murdock (James Watt's ingenious assistant) had also employed cast-iron work to a limited extent in a mill erected by him in Ayrshire; but these were very inferior specimens of iron work, and exercised no general influence on mechanical improvement at that time.

"Mr. Rennie's system of wrought and cast-iron wheels, after a system, was of much greater importance, anw was soon adopted generally on all large machinery. The whole of the wheels and shafts of the Albion Mills were of these materials, with the exception of the cogs in some cases, which were of hard wood, working into others of cast iron; and where the pinions were very small, they were of wrought iron. The teeth, both wooden and iron, were accurately formed by chipping and filing to the form of epicycloids. The shafts and axles were of iron and the bearings of brass, so that the power employed worked to the greatest advantage and at the least possible loss by friction."

The Three-Shift System in the Steel Industry

AT THE joint meeting of the Management and Metropolitan sections of the American Society of Mechanical Engineers, the New York section of the American Institute of Electrical Engineers and the Taylor Society, Dec. 3, Horace B. Drury delivered an address on "The Three-Shift System in the Steel Industry." Mr. Drury was formerly of the Economics Department, Ohio State University and recently with the Industrial Relations Division, U. S. Shipping Board. He has, during the past few months, visited practically all of the steel plants in the United States working under the three-shift system, to collect technical data covering the details of their operation. The excellent paper he presented at the joint meeting was a general review of his findings.

The meeting was held in the Engineering Societies Building, New York City, Fred J. Miller, president of the American Society of Mechanical Engineers, presiding. Discussion of Mr. Drury's paper was led by Robert B. Wolf, consulting engineer, New York City, and participated in by William H. Baldwin, formerly secretary Ohio Steel Co. and S. P. Rectanus, director of employment, the American Rolling Mill Co.

The following is an abstract from Mr. Drury's address:

The actual percentage of steel industry employees who under the two-shift system have been employed twelve hours a day has been variously estimated at from 26½ to 52 per cent. The truth of the matter would seem to be that, so far as concerns those continuous operation processes which make up the heart of the steel industry, such as the blast furnace, the openhearth furnace, and most types of rolling mills, together with the various auxiliary departments necessary to support these processes and make a complete plant, the bulk of the employees work twelve hours. The proportion of twelve-hour jobs in these places is not a full 100 per cent, for the reason that in many of the departments there is a certain amount of work, usually of a common labor or mechanical type, which can be concentrated in the daylight hours and is commonly organized on a ten-hour basis. But all the shift men, all the men whose presence is essential to the carrying on of the processes, from the chemist and bosses down to the lowest helper—the technical graduate, the American-born roller, and the unskilled foreigner—all these, with very few exceptions work twelve hours. Most likely the percentage of twelve-hour workers for the whole plant—which we are assuming is entirely, or almost entirely, devoted to the more fundamental steel processes—will be considerably over 50 per cent, possibly two-thirds.

But while fully one-half of the men in these plants or departments of plants which constitute the seat of the steel industry work twelve hours, the percentage of twelve-hour men taking the American steel industry as a whole, would be considerably less than 50 per cent.

Health of the Worker Is Involved

I wish to remove the impression which may have been created that the matter of health is not involved at all. While the general opinion of well-informed steel men, even those who are very much in favor of three shifts, is that the twelve-hour day is not hard on the men physically, such a statement is probably only approximately correct. It is hard to believe that twelve hours in a shop is as good for a man physically as eight hours in the shop and the balance outside. It seems possible that if we had health records as accurate as those which we will later examine for the quality of openhearth steel, we would find that eight hours would keep a man in better health and increase his longevity in comparison with what it would be under twelve hours.

So it would probably be assuming a good deal to say that the twelve-hour day is in no respects a strain on the health of steel workers. Yet the principal argument against the two-shift system is not the physical argument.

What sort of a home life, one hears it asked on all sides, can a man have who, including the time lost in coming and going, is on the job practically thirteen hours every day? Add to this an hour for meals and eight hours for sleep, and barely two hours a day are left for the duties and pleasures of family and community life. For a few years the ambitious, newly-arrived immigrant may seek such a life; and throughout life, the dull man, or the one-interest-in-life man, may run on contentedly on this schedule. But any definite continuation of such a system for a block of several hundred thousand persons would simply mean the accentuation and continuance in American life of those lines of class and culture which immigration has already made too dangerous and deep. Who wants to have in America a class of men who do not know what to do with themselves unless they are under some one else's orders? Is this the way to raise the general level of literacy and personal capacity, and build up in America a civilization in which we may take pride? The argument against the twelve-hour day based on the proportion of a man's time which it consumes

is in short simply unanswerable both from the standpoint of individual freedom and development, and from the standpoint of national power and culture.

Both Managers and Men Prefer the Three-Shift Day

Perhaps the one thing that stands out the most obviously as a result of my visits to and talks with the managers of the three-shift plants is the fact that practically all of them are glad that they made the change. Not that they had no problems to meet, but they were in practically all cases looking ahead, not back.

Equally important with the attitude of the managers is the attitude of the workers. It has often been pointed out that one of the difficulties involved in changing the steel industry from the two- to the three-shift system is the fact that the men do not want to work the shorter hours. I have made it a special point to talk this phase of the situation over with the managers, and to argue about it with other persons whom I thought could speak for the men, and I am firmly convinced that in times past this has been a very serious obstacle to the introduction of the shorter day. There have been large numbers of foreigners who would just as leave work twelve hours as eight, and who would much rather earn twelve hours' pay. And there have been many others who from pressure of circumstances or because of habit were willing to work twelve hours a day while work was to be had. But with the coming of the war the foreigner found his egress to Europe cut off, and he began to think of America as a place where he could stay a while.

The shortening of a man's day from twelve to eight hours means that the possible energy and attention which he can put into his work in each working hour is greatly increased. But to harness this new energy, as to develop a new country, will take time.

The Matter of Costs

While costs are likely to go up some at the start, I think there is substantial reason for believing, in view of what has already been done in some of the plants, that before long the adjustment will work out along lines that will mean very little if any higher cost.

If hourly wage rates are compromised half way, the force of men increased not a full 50 per cent, but on the average 35 per cent, and if output could on the average be increased 10 per cent, then the labor cost under three shifts would be practically the same as under two shifts. If the first figure were 20 per cent, or the second 30 per cent, or the third 12½ per cent, the others being as they are here, there would be no increase at all.

The experience of all the plants which I have visited shows that the wage adjustment specified is a practical one. Where it is expected that the men will turn out a greatly increased output, or where there is a very material decrease in the number of men, it would be only justice to give the men perhaps as much for eight hours as they had previously earned in twelve. In that case there would of course be no difficulty about labor costs. But assuming that we are not so fortunate as to be able to realize any very large increase in efficiency, it has been shown that the men see the reasonableness of paying for their greater leisure by some reduction in total earnings. This figure of 25 per cent is the maximum that would be required even under conditions of labor shortage.

The figure for a 35 per cent increase in men, instead of 50 per cent is also a conservative one. In many plants exactly 50 per cent more men are employed on three shifts than on two, and most of them are close to the 50 per cent figure. But the 35 per cent standard has been attained by such large plants as those of the International Harvester Co. and Inland Steel Co., and a much better showing was made by the American Rolling Mill Co. It might be noted that the limitation to 35 per cent increase can be obtained if, where ten men are now employed on a shift, it is possible to get along with nine. That is, twenty-seven men employed on three shifts is just 35 per cent more than 20 men employed on two shifts. It seems only reasonable to assume that with so large a reduction in the number of hours, it would be possible to cut out one man out of ten.

This figure for increased output of 10 per cent seems not very far away as an average. It is, of course, too high for a blast furnace. I know of no reason to expect greater output at all from a blast furnace on three shifts. Fortunately in the case of a blast furnace the labor cost is small. In the case of the open hearth furnace a 10 per cent increase in output would be an ambitious program. Most steel men would say that any increase in output at all would be impossible. Others think that wide awake labor can hasten the charging and guarantee that the melting takes place at maximum speed. Fortunately about an open hearth furnace there are ample opportunities for improving the quality of the steel, prolonging the life of the furnace, and saving in materials, which may more than make up for the difficulty of increasing output. As regards rolling mills, the human equation enters in to a considerable extent, so that increase in output may be looked for. The amount depends on the type of mill and the opportunities for doing more rapid work. It would also depend some on the efficiency of the arrangements for supplying the metal to be rolled, and for shearing and taking away the finished product. On many mills, however, actual figures show that the increase in output may run up well toward 25 per cent.

However, the striking thing about the cost of the three-shift system is the smallness of the amount at stake, whichever way one looks at it. Suppose that there were no increase in efficiency at all, that the plant increased its force of shift men precisely 50 per cent, that the output is no greater in any department than under two shifts, and that the hourly wage rates are raised 25 per cent.

Cost Figures

In a good blast furnace plant the labor cost at present wage levels and efficiency should not be far from $1 per ton; to be safe we will say $1.25 a ton. Assuming that the change from twelve hours to eight would affect two-thirds of the men, the pay of these men under the two-shift system would amount to two-thirds of $1.25 or 83 cents per ton. An advance of 25 per cent in the hourly wages of these men would increase the labor cost per ton of pig iron by 21c. Considering the fact that pig iron sells for around $40 a ton, that the ore that goes into a ton when delivered at Pittsburgh costs about $8, the trifling risk involved in increasing the labor cost a maximum of about 21c. is apparent. Likewise in open hearth work the labor cost might be $1.30 a ton; to be safe we will say $1.50 a ton. The maximum increase in labor cost here, assuming no increase in efficiency, would be 25c. Thus the total increase in labor cost for the steel ingot would be not more than 46c., still a small figure for something that sells for about as many dollars. In the rolling mills the labor cost will run higher, especially where material is rolled several times, and into light shapes, as rods, sheets, etc. But in proportion as the product is put through many processes the opportunities for getting higher labor efficiency increase, until at the sheet mill end of the process no one questions but that the shorter day means no added cost at all. In various of the rolling mills visited there has been no increase in labor cost.

The magnitude of the problem of finding the extra labor is not nearly so great as is commonly supposed. As for the higher positions, these may be filled by promotion of helpers. This promotion in itself has a favorable effect on the men, as the better workers make up in promotion for what they would otherwise lose because of decreased earnings. The lower positions may be filled by new labor.

However, under present conditions, the time may soon be at hand when the three-shift system could be introduced without bringing any new labor into the industry. If indeed we are face to face with a time of considerable unemployment in the steel industry, then this would be the time of all times to cut out one man's working twelve hours a day, and another's working not at all, and distribute the work so that all would have employment for a reasonable work-day. Under these conditions the change can be made with the greatest benefit all around, and perhaps no cost anywhere.

Cylindrical Grinding in 1920*

By W. H. CHAPMAN

(Continued from last week's issue.)

THE most important development in recent grinding machines is the recognition and utilization of the fact that overall operating efficiency for traversed cylindrical work *increases as traverse speeds are increased.* (This assumes that for a given traverse speed width of wheel and revolution of work are so related as to cause the cutting face to just cover the lead of the work.)

This fact is based upon certain scientific laws. It will now be shown why this is true and an expression will be derived for determining the effect of traverse speeds. Professor Alden did not go into this question, and Mr. Guest apparently did not recognize the true conditions as he considers traverse speed of negligible effect.[2]

It is evident what grain depth of cut is, and how it affects wheel wear. The wheel width of cut also affects wheel wear. If we consider, for instance, the resistance offered to forward motion of a snow plow we know that if the plow is set at an angle it is easier to push, although we will have to push it further to clean off the same area of surface than when it is set exactly against the direction of the path.

Consider the grinding wheel as stationary, non-rotating, and the work to revolve. If the work is traversed the path will be a helical ribbon. The width of this ribbon measured parallel to the axis of rotation of the work is the same as the cylindrical path cut by the wheel when the work is not traversed. For the same *angular* movement of the work both paths are of equal area. The work done is the same. In the case of the traversed work, however, the resultant motion between wheel and work is at an angle to the axis of rotation. The tangent of this angle is the length of the projected arc, or circumferential distance traveled by the work, divided by the distance traversed in the same time. The actual length of the path measured in the direction of this relative motion is greater than the length of the projected arc, while the width of path perpendicular to this length is less than the width of the straight-in cut. The length of cut becomes equal to the length of equivalent straight-in cut divided by the sine of the traverse angle or lead angle of the work. The width of path is diminished in the same proportion, being the width of the straight-in cut times the sine of the traverse angle whose tangent was given above. With the wheel still at rest, we see that we have reduced the wheel width of cut by the proportion of the sine of the traverse angle. Referring to Fig. 2, let

W = width of wheel face;
L = length of projected arc of rotation of work;
M = actual length of path of traversed cut;
B = actual width of path of traversed cut;
β = traverse angle.

Then $B = W \sin \beta$; $M = L/\sin \beta$; areas $W \times L$ and $B \times M$ are equal. Wheel width of cut is proportional to W for straight-in cut, but reduced to B for traversed cut.

It is to be noted that relative work speed has been increased over actual work speed in the inverse proportion of the sine of the traverse angle. This relative increase does not appear in the projected (end view) relations. As these alone affect individual grain depth of cut we have gained in relative work speed to get over the longer path M, so as to cover the same area in the same time on a narrower width B, *without* increasing grain depth of cut.

Now, if the wheel rotates each grain cuts across the work at an angle θ, resulting from speed relations shown by Fig. 2 (vector diagram for rotating wheel). Then the individual grain paths are at a much steeper angle

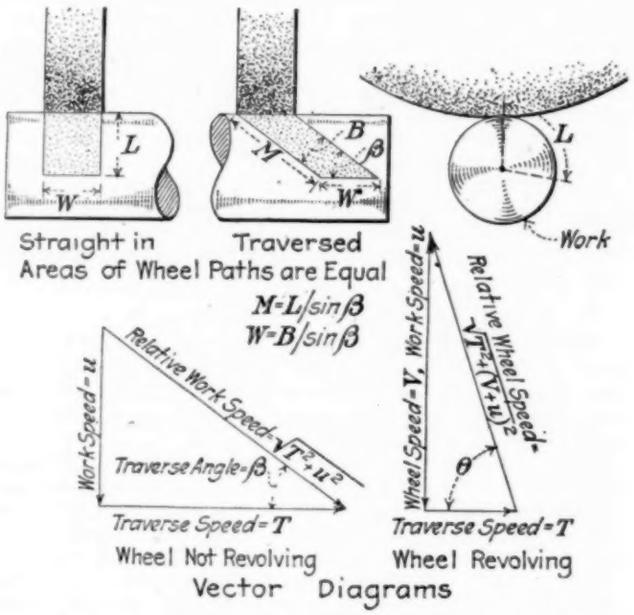


FIG. 2. SPEED RELATIONS BETWEEN WORK AND WHEEL

than the wheel path to the axis of work rotation, but we have gained in relative wheel speed *without* increasing individual grain depth of cut. Our wheel width of cut is also reduced by a slight amount proportional to sin θ, which is, of course, much less than the reduction before the wheel was rotated. The net result is a reduction in wheel stress proportional to sin θ and an increase in work speed proportional to sin β, *without* increase in grain depth of cut.

The "head resistance" against the wheel as a whole is reduced by the sin β factor, while wheel width of cut is reduced by sin θ. These both directly affect wheel wear. For traversed-feed conditions our grain depth of cut remains the same as in straight-in feeds, but wheel wear is reduced in the proportion of sin $\beta \times$ sin θ.

If T = traverse speed, V = wheel speed, u = work speed, then

$$WW_1 = \left(\frac{u}{\sqrt{T^2 + u^2}}\right)\left(\frac{V + u}{\sqrt{T^2 + (V + u)^2}}\right)\left(\frac{\mu u}{rV^2}\right)\sqrt{2rf} \quad (8)$$

In practical cases the second term will be so nearly 1 that it may be neglected. It is evident that T affects the quantity appreciably only when u is kept relatively

*Presented at the annual meeting, New York, December, 1920, of the American Society of Mechanical Engineers, 29 West 39th Street, New York.

[2]See "Guest's Grinding Machinery," Arnold, 1915 edition, p. 80.

low. This indicates that a wide wheel should be used to get the effect of reduced wear for a given production, traversing as rapidly as possible. The above formula assumes no overlapping of the cut.

Now by making assumptions and neglecting values whose effect is so small as to make no appreciable difference for purposes of comparison we reduce the expressions for WW_I exactly as we did in the case of straight-in feeds and obtain:

$$\text{Index of wheel wear } WW_I = \frac{\mu u}{V^2}\left(\frac{u}{\sqrt{T^2+u^2}}\right)\sqrt{\frac{2f}{r}} \quad (9)$$

Laws of Grinding for Traversed Cuts

From this it is evident that for traversed work:

a Wheel wear increases directly with the work speed;

b Wheel wear decreases directly as the decrease in the quantity which we term "traverse factor," which is work speed divided by the square root of the sum of the squares of traverse and work speeds;

c Wheel wear decreases directly as square of wheel speed increases;

d Wheel wear decreases directly as the square root of the work radius increases;

e Wheel wear increases directly as the square root of the feed increases.

The value $\frac{u}{\sqrt{T^2+u^2}}$ in our expression for index of wheel wear is our traverse factor. Where T is large with respect to u this factor will be appreciably less than unity, but as u increases the reduction in wheel-wearing action is less pronounced.

Table II gives values of the traverse factor for a certain machine having the work speeds previously given for draw-in cuts, and the following table (traverse) speeds: 10.02, 14.00, 17.00, 19.70, 26.90 and 32.60 ft. per min. The table shows combinations of speeds giving leads from 2.3 in. upward. As the machine was designed for a wheel 2½ in. wide combinations of speeds giving lesser leads of work are not given.

If we now multiply each of the traverse factors in Table II by the wheel-wear value for the corresponding work speed and work diameter as shown in Table I (draw-in cuts), we will have a table of wheel-wear values for traversed cuts. These products are given in Table III.

By assigning certain wheels to specified ranges of wheel-wearing action we may select the proper wheel through the use of Table III in the same way that we did from Table I. Actually, in the case of Table III, the wheels used would be somewhat softer for the same index figure because the actual depth of cut does not follow the indicated depth (as shown by the feeding mechanism) as closely for traversed work as for draw-in work, and therefore the actual cut is not so deep. This means, of course, that the "spring away" action of the work is more pronounced for traversed than for draw-in work. Careful use of steady rests is therefore very essential.

TABLE II. TRAVERSE FACTORS

Traverse, Ft. per Min.	Work, R.p.m.	Lead, In.	Work Diameters 1 In.	2 In.	3 In.	4 In.
10.02	53	2.3	0.810	0.950	0.975	0.985
14.00	53	3.1	0.705	0.883	0.946	0.968
14.00	72.5	2.3	0.805	0.938	0.968	0.976
17.00	53	3.8	0.632	0.850	0.926	0.955
17.00	72.5	2.8	0.730	0.910	0.955	0.974
17.00	87	2.3	0.802	0.935	0.972	0.985
19.70	53	4.4	0.576	0.817	0.905	0.943
19.70	72.5	3.2	0.691	0.884	0.943	0.967
19.70	87	2.7	0.756	0.916	0.961	0.980
19.70	101	2.3	0.802	0.935	0.971	0.986
26.90	53	5.9	0.460	0.720	0.839	0.900
26.90	72.5	4.4	0.574	0.815	0.902	0.942
26.90	87	3.6	0.646	0.860	0.931	0.958
26.90	101	3.1	0.703	0.890	0.950	0.974
26.90	138	2.3	0.801	0.936	0.960	0.982
32.60	53	7.35	0.397	0.655	0.790	0.865
32.60	72.5	5.3	0.505	0.760	0.867	0.919
32.60	87	4.4	0.580	0.815	0.908	0.945
32.60	101	3.8	0.635	0.854	0.927	0.960
32.60	138	2.8	0.748	0.914	0.945	0.977
32.60	167	2.3	0.807	0.936	0.967	0.982

TABLE III. WHEEL-WEAR VALUES FOR TRAVERSED CUTS

Traverse, Ft. per Min.	Work, R.p.m.	Lead, In.	Work Diameters 1 In.	2 In.	3 In.	4 In.
10.02	53	2.3	0.01340	0.02240	0.02820	0.03280
14.00	53	3.1	0.01170	0.02080	0.02740	0.03230
14.00	72.5	2.3	0.01820	0.02450	0.03775	0.04390
17.00	53	3.8	0.01050	0.02005	0.02685	0.03185
17.00	72.5	2.8	0.01650	0.02900	0.03720	0.04370
17.00	87	2.3	0.02190	0.03620	0.04620	0.05390
19.7	53	4.4	0.00955	0.01930	0.02620	0.03142
19.7	72.5	3.2	0.01560	0.02820	0.03675	0.04350
19.7	87	2.7	0.02060	0.03540	0.04570	0.05355
19.7	101	2.3	0.02540	0.04185	0.05245	0.06260
26.9	53	5.9	0.00763	0.01695	0.02430	0.03000
26.9	72.5	4.4	0.01290	0.02600	0.03520	0.04240
26.9	87	3.6	0.01760	0.03320	0.04420	0.05235
26.9	101	3.1	0.02220	0.03980	0.05125	0.06185
26.9	138	2.3	0.03470	0.05130	0.06195	0.08500
32.6	53	7.35	0.00660	0.01545	0.02290	0.02885
32.6	72.5	5.3	0.01140	0.02420	0.03380	0.04130
32.6	87	4.4	0.01580	0.03150	0.04315	0.05160
32.6	101	3.8	0.02000	0.03820	0.05000	0.06100
32.6	138	2.8	0.03230	0.05580	0.06095	0.08450
32.6	167	2.3	0.04210	0.06940	0.08800	0.10230

The following wheels are found to be satisfactory for our machine for traversed cuts on mild steel under the assumed conditions:

Wheel Designation		Wheel-Wear Values Table III
36 or 46 I	for values up to	0.02500
36 or 46 J	for values from	0.02500 to 0.04000
36 or 46 K	for values from	0.04000 to 0.05000
36 or 46 L	for values from	0.05000 to 0.06000
36 or 46 M	for values from	0.06000

Use No. 60 grain for hard material and a grade softer; but use no wheel softer than I.

Important Note. These statements of wheel assignment are based upon assumptions of the best machine conditions and most careful operation to prevent any abuse of the wheel. Field practice will usually show harder wheels in use due to conditions which abuse the wheel. Efficiency is sacrificed where such is the case.

Production Costs

Grinding efficiency is usually considered as (production) ÷ (wheel wear). It is expressed as cubic inches of material removed per cubic inch of wheel wear. If wheel wear were the most important element of production cost grinding efficiency might be considered on this basis without leading to the fallacy which exists today. As a matter of fact the wheel cost is almost negligible compared to the other costs, and wheel selection should be based upon the production capacity of the wheel under the given set of grinding conditions, allowing the wheel wear to be as high as is necessary to get a free action without excessive wear (which would cause difficulty in sizing work and the need for frequent dressing). The all-important factor is the rate at which the wheel may be made to cut and still not get out of truth. This affects the grinding time, any reduction of which is of vastly more

importance than an increase of wheel wear which may result from such a reduction.

In good practice the volume of wheel wear is approximately a tenth of the material removed (mild steel) during roughing operations. A conservative estimate of the cost of operating a modern cylindrical grinding machine (exclusive of wheel cost) is, say, 5c. per min., including labor at day-rate wages.[3] The useful content of the wheel may be assumed to be such that the wheel is actually worth 7c. per cu.in. If production could be increased to 2 cu.in. per min. where previously we obtained 1½ cu.in. and wheel wear jumped from 0.15 cu.in., say, to 0.25 cu.in. per min., our first cost would be: $(0.05 + 0.15 \times 0.07) \div 1.5 =$ \$0.0404 or 4.04c. per cu.in. removed. In the second case, $(0.05 + 0.25 \times 0.07) \div 2 =$ \$0.0338, or 3.38c per cu.in. removed.

Now the over-all production efficiency of the machine based upon all costs involved is indicated by production-cost factors proportional to the earning rate of the machine. In the first case this factor would be (production) $\div$ (cost) $= \frac{1.5}{0.05 + 0.15 \times 0.07} = 24.8$. In the second case, $\frac{2.0}{0.05 + 0.25 \times 0.07} = 29.6$.

It evidently will pay to wear the wheel more in order to obtain the higher rate as the over-all gain in the foregoing is about 19 per cent. The above-assumed values are reasonable and the figures given might be considered as typical. Table IV gives these production-cost factors, or relative earning rates based upon these costs and the grinding conditions previously assumed in Tables I, II and III, the variations being due to traverse and work-speed relations only, but with proper choice of wheels in each case. Then, for the machine which we have used as an illustration it is evident that for work of a certain size and a wheel of a certain width there is one speed combination which will utilize the machine to the greatest profit. If we are able to use wheels of the width needed to cover the lead under the best speed-relation conditions we will obtain the best earning rate of which the machine is capable. If wide wheels are not available we still have speed-relation conditions which will give very nearly as high a rate for the narrower wheels.

In Table IV the production-cost factors are given for 1-in. and 4-in. diameters of work only. The factors may also be expressed as earnings per unit of time, or the relative amounts the machine would earn in equal lengths of time under the various conditions as given.

Note that, due to high traverse, a 2.3-in. wheel which earns \$3.68 in a certain length of time when grinding 1-in. work at low traverse and work speeds will earn \$10.62 in the same length of time when using the high speeds. If the widest wheel (7.35-in. face) be used the machine will earn \$11.70 in the same length of time. The grade of wheel is suitable in each case according to the speed changes. This clearly shows that high traverse speeds cause a corresponding increase in earnings in spite of the necessary increase in work speed.

Considering the cost of wheels 7.35 in. wide as compared to wheels 2.3 in. wide, and the relative power

[3]The figure of 5 cents a minute as time cost of operation is based upon labor at 75 cents an hour and an hourly burden of \$2.25 an hour (power, investment, rent, heat, light, etc.).

TABLE IV. PRODUCTION-COST FACTORS

Table Speed, Ft. per Min.	Work, R.p.m.	Lead, In.	— Diameter of Work — 1 In.	4 In.
10.02	53	2.3	3.68	13.45
14.00	53	3.1	5.16	18.80
14.00	72.5	2.3	4.95	17.85
17.00	53	3.8	6.00	21.00
17.00	72.5	2.8	6.00	21.80
17.00	87	2.3	5.85	22.00
19.70	53	4.4	6.40	23.70
19.70	72.5	3.2	6.80	23.50
19.70	87	2.7	6.84	23.45
19.70	101	2.3	6.75	23.30
26.90	53	5.9	9.05	29.80
26.90	72.5	4.4	9.34	29.85
26.90	87	3.6	9.00	29.00
26.90	101	3.1	9.03	29.10
26.90	138	2.3	9.00	29.15
32.60	53	7.35	11.70	35.70
32.60	72.5	5.3	11.30	34.60
32.60	87	4.4	11.00	33.60
32.60	101	3.8	10.90	33.40
32.60	138	2.8	10.80	33.30
32.60	167	2.3	10.62	32.90

required to drive the two wheels, it is very evident that the use of a harder wheel 2.3 in. wide would offset the difference in wearing action without greatly reducing production and that the production of the 7.35-in. wheel is matched by the production of the 2.3-in. wheel using highest traverse and highest work speed.

The most striking conclusion from the above is the fact that in order to use a narrow wheel and get great production the high work speed does not cause excessive wheel wear *due to the relief* on the wheel brought about by the *high traverse speed*. This traverse speed is also necessary to allow the rapid exposure of fresh work surface to the cutting face, making for a highly economical combination.

The foregoing should demonstrate clearly what this new development in the science of grinding may mean to the art as practiced throughout our production shops.

Actual grinding tests upon a machine having the high-traverse feature, and making use of the speeds shown in the table, have conclusively proven the deductions indicated by the mathematical calculations. On mild machine steel (0.15 per cent carbon) over diameters ranging from ¾ in. to 4 in. production rates as high as 2 cu.in. per min. have been easily attained, grinding to limits of 0.0010 in., removing 0.060 in. from the diameter over lengths of from 36 to 72 in.

When machine conditions, truth and balance of wheel, and proper use of steady rests and grinding compound are intelligently and skillfully handled wheels of 36 and 46 grain size, and grades I to L (Norton system of grading) have been used in these roughing operations. Especially where the feeding is carefully regulated so as *never* to *crowd* the *radial depth* of cut to more than the possible depth of grain penetration (say not to exceed 0.0015 in. on the diameter) per traverse it has been found that the wheel face remained sufficiently true to leave a commercial finish of fair degree absolutely free from chatter marks, feed lines or any other imperfections of real or imaginary consequence.

Owing to the fact that in the above the highest work and traverse speeds were used in every case the grade (hardness) of wheel was increased as the diameter of the work increased. This is in accordance with our formula for index of wheel wear. Instead of considering the work speed and work radius independently, they were in this case tied together by the fact that a constant work r.p.m. was used. The expression for this is as follows:

$$\text{Work speed } u = \frac{2\pi rN}{12} \quad (9)$$

where r = work radius (inches) and N = r.p.m.,

Formula (8) for traversed cuts, with second and third terms omitted as unimportant, becomes

$$WW_1 = \frac{\mu u}{V^2}\left(\frac{u}{\sqrt{T^2 + u^2}}\right)\sqrt{\frac{2f}{r}} \quad (10)$$

Substituting (9) in (10),

$$WW_1 = \frac{0.275\mu}{V^2}\left(\frac{N^2}{\sqrt{T^2 + 0.275r^2N^2}}\right)\sqrt{2fr^3} \quad (11)$$

Now if V, N, T and f are made constant WW_1 must vary as the value r appears in the formula, the greatest effect being the $\sqrt{r^3}$ factor, and we would expect, therefore, to use harder wheels as r increases.

Conclusions

The conclusions to be drawn from the foregoing are definite and indicate positively how to arrive at the solution of precision grinding problems, provided one has an intelligent knowledge of abrasive wheels and the usual materials ground.

Theoretical Conclusions (Cylindrical Grinding). Great grinding efficiency is obtained by the use of the *softest wheels* suited to the nature of the material ground. This efficiency is dependent upon the control of the dimension and speed relations between the wheel and the work so that the individual chip may have the minimum depth for a given volume determined by the maximum allowable radial depth of cut. This means long arc of contact, low work speeds and maximum feeds.

With the above conditions established, *increase of traverse speed increases production without increase of wheel-wearing action.*

Practical Conclusions. Machine conditions must be such as to maintain as accurately as it is reasonably possible the speed and dimensional relations of the wheel and the work. This includes a great number of individual factors, any one of which may serve to entirely or partially impair the successful operation of the machine in following the theoretical fundamental laws as previously stated. It is entirely worth while to emphasize here some of the most important of these.

a The power drive must not allow speed variations unless under the willful control of the operator;

b The wheel must be in good running balance and in absolute truth, and must be held in its position relative to the work within the closest possible limits;

c The work must be accurately held with respect to the wheel and must be *uniformly* rotated. Relative traverse between work and wheel must be uniform;

d The work must be rigidly supported over its entire length and no vibration allowed to occur between centers;

e Feed control must be sensitive and accurate and feeding must be at a rate such that the feed increment *never exceeds the maximum grain penetration.* This is the most frequently violated of the factors involved;

f Work must be kept at a uniform temperature and local heating prevented at all times. A copious supply of grinding compound should be directed to the *arc of contact* at all times. Eccentric work due to bowing from heat effects is the usual result of failure to supply sufficient compound at the arc of contact. In truing the wheel with a diamond the use of the cooling medium is vital to accuracy. Save the diamond by using a dresser to roughly true a wheel, using the diamond only when necessary to put the wheel in exact truth for precision work. Never feed a diamond over 0.001 in. per traverse;

g Select wheels intelligently, and do not try to use a single wheel for a variety of work sizes or materials unless the job is too short to warrant efficient grinding as compared with the time of changing wheels. It is seldom that this is true. Hard work (hardened steel, manganese steel, stellite, etc.) requires soft, rather fine wheels. The fine grain reduces the chip size but removes more chips, and wheel wear is not so likely to cause a pounding of the wheel, nor will the small grain cause the glazing which is bound to occur with coarse, hard wheels;

h An accurate finish requires the use of a soft, free-cutting wheel so controlled that the chips are very small (light feed and slow work speed with traverse to make the wheel face just cover the lead);

j A burnished finish may be obtained by a peening action of a coarse, hard wheel trued dead smooth. Heating and inaccuracies of surface are likely to occur;

k Cases are rare where a wheel harder than grade M may be properly used in cylindrical grinding. Low wheel speeds, too small a wheel, too high a work speed and abusive feeding—these are usually the causes for the use of hard wheels. Mention should also be made of failure to take draw-in cuts to establish traverse limits, thus requiring too hard a wheel in order to make the "corner stand up." Along this line may properly be mentioned design and drafting-room practice in calling for sharp shoulders where a generous fillet might be allowed. This makes needles, difficulty in grinding and weakens the piece ground;

l The contact of the wheel face with dry work at any time immediately ruins its value for finishing. The common practice of just touching the dry work when bringing up the wheel to contact is wrong, due to the charging of the wheel face with the uncooled chips (loading).

When the machine is properly designed and operated the grinding action will closely follow the theoretical laws. These laws are always at work, and when there is apparent conflict between the theoretical and the actual there exists some fault in the machine or with its operator. There is an enormous field for the industrial engineer in obtaining better production at less cost in grinding operations. There is a definite science involved, there is no mystery about it. The proper appreciation of the laws of grinding by machine designers and operators is rapidly increasing and we may expect a constant improvement in the art as a consequence.

The Cost of Labor and the Labor-Cost

By ELMER W. LEACH

The suggestion that the cost of labor, or wages, be kept up by reducing the labor cost, or increasing production per man, is no new idea but Mr. Leach's method of presentation is original and convincing.

ASK a man the difference between a quarter of a cubic inch and a cubic quarter of an inch and you've got him guessing—the chances are he'll have to get a pencil and paper to convince himself that you are not joking. And the title to these few remarks is just like that interesting mathematical problem in that there really is a difference between the two terms, and that difference is by no means a joke.

Only yesterday I had occasion to purchase some soft collars (the first ones for a long time, I'll admit), and plain white linen collars of a kind that one wears to the office each day were selling at fifty and seventy-five cents each. Prices did do some queer things while some of us were drawing our clothes from Uncle Sam's Q. M. depots and it's a bit hard to accustom ourselves to the changes that took place while we were away, but frankly, I had expected soft collars were selling at about fifteen cents each, possibly two for a quarter.

"Can you imagine it?" a stout gentleman remarked rather indignantly, "seventy-five cents for a soft collar. And look at that next counter, twenty and twenty-four dollars for a silk shirt. How long is it going to last anyway?"

The clerk had the right idea for he replied pleasantly as the stout gentleman walked away without purchasing, "I'm sorry, sir, but really we can't sell them for any less until we can buy them for less."

In the morning one of our crack salesmen had just returned from a most discouraging trip through probably fifteen states. "You simply can not sell them," he told the sales manager. "Everyone seems to be waiting for a drop in the market. No one cares to stock up on anything because he feels something is going to happen."

Now the real fact is that we are still getting steel and pig iron under some contracts made several months ago; and if our present prices were based on today's raw material market instead of the costs we obtained under those old contracts we should have to be charging at least 10 per cent more than we are charging for our goods.

But the dealers are looking for a 20 per cent drop and not a 10 per cent raise. And so the sales manager is writing some very pertinent letters:

"There can be no appreciable reduction in the prices of our goods until we are able to reduce the cost of production. This will only be possible when we can purchase our raw materials for less money, and when we can lessen the labor cost of our products; and we see no immediate prospects of being able to do either of those two things."

Whether we like to admit it or not, that paragraph smashes the nail pretty squarely on the head. It isn't exactly how we would arrange the problem if we were writing a story, but it is the problem nevertheless; and it will be solved and eliminated only when each one of us has studied out just what his individual part in its solution is.

In one of his plays Shakespeare has a character say something to this effect, "The fault is not in our stars but in ourselves that we are underlings."

I cannot help but wonder if that same thought is not applicable in the present situation. Before this article can appear in print the events of the political campaign will have passed into history; but at the time of writing, and particularly in the writer's Middle-Western state, so-called "people's candidates" are shouting "Death to the profiteers," and are telling of all the legislation they will enact to reduce the cost of living.

Perhaps I am overstepping the bounds of propriety and caution in this next remark, but it is my own personal opinion that the fault is "not in our Senators but in ourselves" that the cost of living and the cost of production are not sliding down hill as fast as we should like. And by that I mean that all the legislation in the world cannot reduce the cost of living any more than it can control the rate of foreign exchange.

It's a job for individual effort, which means that you can help and I can help—all of us helping together is what will bring about the desired result.

"But," you ask, "what has all of this to do with the labor-cost or the cost of labor? What have Senators and soft collars to do with what we thought you were going to talk about?"

In my title I use the expression "cost of labor" to represent the price or the wages that we are paying today to the men of industry. And by the "labor-cost" I mean that portion of the manufacturing cost of an article which is incurred through a workman putting part of his time into the making of that article. Putting it into dollars and cents, the cost of labor for a certain man might be $35 a week, whereas the labor-cost of the part he was working on might be one cent or a hundred dollars, depending on how many of those parts he turned out in a certain period of time.

If your position is such that you are sitting in the directors' meetings of some large manufacturing concern, if you are a member of your Shop Conference Committee, or even if you are one of those who take part in the "dinner-pail dialogues" that hold forth in almost any corner of the shop during the noon hour, you must know this thing to be a fact—that not a single manufacturer in the country really wants to lower the wages of his employees. Instead, it is the "labor-cost" of their product that they want to bring down, and they are trying to accomplish this by finding simpler ways of doing things and better methods for turning out more work in a given time.

If you can help them to do that by buckling down a bit more seriously and more conscientiously to the job and increasing your own individual production not a boss in the land will be so ungrateful as to deny you a share of the saving you will have effected for him—it is far more unthinkable that he would give you less money for having helped him to make more money.

There is a class of agitators among us today who

claim that Capital and Labor have nothing in common. They would make these two opposing factions rather than two co-operating groups. If we are to have anything but industrial chaos and disorder in this good land of ours during the years that lie ahead we must realize that Capital and Labor have got to stand on common ground and pull together in meeting the gigantic problems that face them both.

It would be as foolish to attempt to preserve the sanctity of the marriage state by arraying the fathers and mothers of the country in direct opposition to each other and telling them that they had no common interest in the future of the great American home, as it would be for the employer and the men who work with him to dare hope that the Stars and Stripes might continue to float over a land of successful business and industrial accomplishment if either of them believed, for one moment, that he could get along without the help and the co-operation and the good will of the other.

Increased production will lower the cost of things just as effectively and much more satisfactorily than decreased wages. That is what the directors of companies are saying today in their meetings, and it is what they are trying to bring home to their employees in every possible way. But increased production must go hand in hand with industrial teamwork if it is to be truly beneficial.

If you will pardon the illustration, the best of near-beer is a poor substitute to those who indulged in the genuine article because there is a "kick" that is lacking. It was the kick that made the real stuff the real stuff.

The workingman of today must put the same kind of a kick into his efforts, a push or an incentive that will give him the spirit of wanting to produce more. If he will read a recent issue of any of the trade papers he will see its pages devoted largely to articles on Better Relations, Bonus Systems, Premium Plans, Profit-sharing Arrangements, Foremen's Committees, Industrial Self-Government, and similar subjects. He must realize that the employer who is building his business on solid ground is spending a great deal of time devising means for making partners of his employees to participate with him in sharing and enjoying the results of their common labors.

He must realize that when business leaders of today talk about "reverting to the old order of things" they do not mean stepping backward to $50-a-month wages and 10-cents-a-dozen eggs; but rather do they mean going back to the old order by going ahead through a new conception of each man's individual duty to a fairer proportionate relation of price and profit to production.

The day is gone when Labor was considered a commodity to be bargained for the same as pig iron and coke. Gone also is the day when the mechanic was merely a part of his lathe. In these days of domestic reconstruction, just as surely as in the day when a foreign danger threatened us, we must work together if we are to carry out the necessary readjustment in an orderly manner.

Individual and Collective Effort Necessary

If we have faith in ourselves and in the future of our country we can easily believe that there are better days ahead for all of us; days of greater prosperity through a lower cost of living; days in which we can expect our work to contain a little less of the drudgery that is next to slavery and a little more of the pleasantness and sunshine that makes life worth living.

Kipling has very aptly said in one of his poems:

"It ain't the individual, nor the army as a whole;
But the everlasting teamwork of every blooming soul."

We all agree with the hesitant purchaser of today that something has got to happen. We cannot help but believe in the salesman's remark that one must buy for less before one can sell for less. Both ends of that problem tie up very definitely with each one of us, but we must tackle the first phase of it first, that of making it possible to buy for less, and the second will naturally follow.

If we all make it our own personal problem to increase our own productivity, no matter what our work may be, we shall be doing our bit toward lowering the labor-cost of commodities; and when we can do that it will not be necessary to worry about a reduction in the cost of labor.

Correcting Hand Reamer Chatter

By J. C. Nicholson

Trying to ream a straight hole by hand is a troublesome job, but it is so often necessary in certain kinds of work that a suggestion on the matter may be welcome. The most annoying feature in the operation is chatter and, contrary to what is usually expected, this is only made worse by using a double-end wrench unless by rare good luck and great care the reamer is well entered before chatter begins, whereas it is just at this point that chatter is most likely. Of course the whole trouble is due to having no fixed guide for steadying the shank end, but recourse may be had to another aid.

As in all cases of chatter one of the simplest remedies is something that will cause the cutting edge to spring or move away from the work when the pressure of cut increases. Of course a reamer cuts with each land, making this alternative seem needless, but owing to the use of a wrench for turning it, there are four points at which chatter is likely to occur; namely, at two points on a line parallel to the wrench handle and at points at right angles to these. In the first case pressure on the wrench toward or away from the work on either side sets up an unbalanced condition. In the second the same unbalanced state results from unequal pressure on opposite ends of the wrench in turning it.

Now this unbalanced condition is not always a bad thing so far as chatter is concerned. On the contrary it may even be used to prevent chatter. But in using a double-end wrench it is practically impossible for one to tell by the feel of the wrench whether it is going to act in the right direction. By using a single-end wrench, however, this is possible. As the wrench is pulled around one way the right hand use the left hand on the extreme end of the reamer pressing a little harder in the *opposite direction*. A little thought will show that this gives the state of unbalance which prevents rather than causes chatter, and it works beautifully. Of course such a procedure tends to make a taper hole, but so does chatter, which has additional objections.

The suggestion has particular force when for any reason it becomes necessary to ream one hole over to one side into alignment with another and also when using an expansion reamer in babbitt.

Side-Cutting of Thread-Milling Hobs*

BY EARLE BUCKINGHAM

It has long been known that, due to the helix of a thread, the side-cutting action of a hob distorts the form of the thread on the work. In other words, the form of the tooth on the hob is not reproduced on the threaded part. The present paper is the result of a mathematical investigation of this subject and points out the corrections in the form of thread-milling hobs which can be readily made and also produce threads sufficiently correct as to form for all practical purposes.

THE profile of the thread cut with a hob is a combination of two distinct curves. First, a small fillet is formed at the root of the thread which is the path of the outside corner of the hob. No correction in the form of the hob is possible to correct this point. Second, the larger part of the flank of the thread consists of a slightly curved profile which is formed by the overlapping paths of the infinite number of cutting points which form the cutting edge of the hob. Mathematically, a curved correction can be applied to the form of the hob which will correct this profile entirely. Practically, a straight-line correction can be applied which is almost exact, as the amount of the actual curvature on the flanks of the thread is seldom greater than one-tenth of a thousandth part of one inch. The greater the angle of helix of the thread, the greater the amount of correction necessary.

One very interesting fact is that the diameter of the hob has no effect on the form of the main part of the profile. The actual amount of side-cutting is more and the height of the fillet at the root of the thread is greater, as the diameter of the hob is increased, but the rest of the profile is unchanged.

This paper deals with both externally and internally threaded parts. The general conditions of side-cutting are identical in both cases. On a screw, however, the flanks of the hobbed thread will be convex, while in a nut they will be concave. Furthermore, the height of the fillet at the root of the thread and the actual amount of side-cutting are relatively greater in a nut than on a screw.

When a thread is chased in a lathe and the cutting tool has proper clearance and is set so that the plane of the cutting edges contains the axis of the thread, the exact form of the tool will be duplicated on the work. Assuming that the thread is completed, if the tool in its cutting position is brought into contact with the flanks of the thread, it will have a line bearing only. If sufficient clearance can be provided on the tool, this holds true regardless of the pitch of the thread, the angle of the flanks, or its diameter.

When a thread is hobbed, however, the axis of the hob being parallel to the axis of the thread, the path of any one cutting point is a circle, and this circle will interfere with the helix of the thread to an amount depending upon the pitch of the thread, the angle of the flanks, and the diameters of both hob and thread.

*Presented at the annual meeting of the American Society of Mechanical Engineers, New York, Dec. 7 to 10, 1920.

It is assumed in this discussion that the cutting teeth of the hob are backed off sufficiently to prevent any dragging of the relieved portion of the tool on the work. The interference between the cutting edge of the hob and the helix of the thread therefore results in the removal of additional metal, thus distorting the form of the thread. The amount of this distortion varies as the values of any of the following factors change: The pitch of the thread, the form of the thread, the diameter of the work, and the diameter of the hob.

It will be shown that correction for some of this distortion inevitable with this method of manufacture is impossible. The amount of this distortion, however, can be reduced in many cases by the proper relation between the diameters of work and hob. It will also be shown that most of the distortion can be corrected by a suitable alternation in the form of the cutting tool.

THE HOBBING OF SCREWS

In Fig. 1, which shows a diagram of a hob and screws, let

R = radius of any cutting point on the hob;
r = radius of deepest point on work touched by R;
N = number of threads per inch;
A = angle of rotation of hob;
B = angle of point of contact of R at angle A;
C = ½ included angle of thread;
r' = radius of point of contact of R on work.

Formulas will first be derived to show the interference between the path of any cutting point on the hob and the flanks of the thread and for purposes of plotting the value of y will be taken as the radial

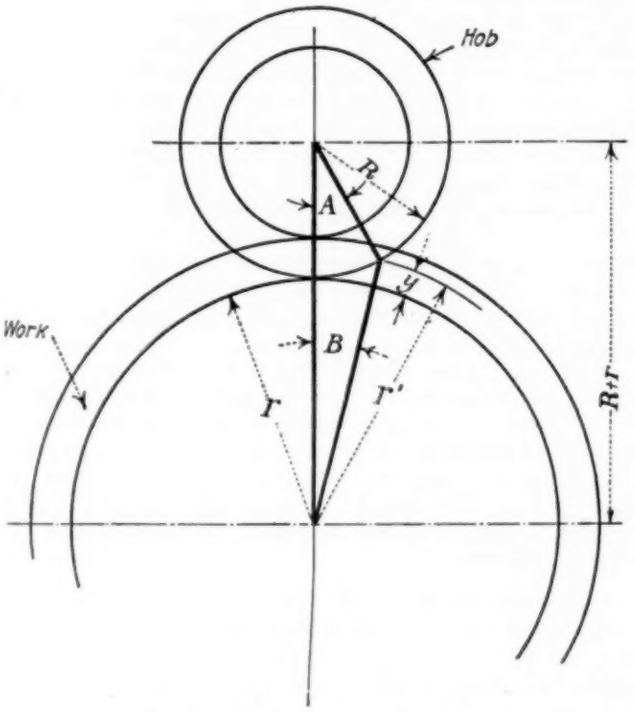


FIG. 1. DIAGRAM OF HOB AND EXTERNAL SCREW

distance of the cutting point R from the deepest point on the work touched by R. In other words,

$$y = r' - r \qquad (1)$$

The value of x will be taken as the longitudinal (or axial) distance of the cutting point R from the flank of the theoretical thread. A plus value of x will indicate a clearance, while a minus value of x will indicate an interference or side-cutting.

In order to determine the value of y the triangle shown in heavy lines in Fig. 1 must be solved. The known factors will be taken as r, R and B. We first have

$$\frac{(R+r)\sin B}{R} = \sin 180° - (A+B)$$

$$\sin 180° - (A+B) = \sin (A+B)$$

$$\frac{(R+r)\sin B}{R} = \sin (A+B) \qquad (2)$$

From this equation we determine the value of A. Solving the triangle for r', we have

$$r' = \frac{R \sin A}{\sin B} \qquad (3)$$

and when the value of r' is determined, the value of y is established from equation (1).

As the hob revolves away from the common center line of the hob and work, the cutting points on one side of the tooth of the hob, due to the helix of the thread, will have a clearance with the flank of the thread, while the cutting points on the other side of the tooth of the hob will develop an interference. The particular side involved depends upon the direction of the helix of the thread, whether left-handed or right-handed. But the side of the hob which clears the helix as the cutting point revolves away from the common center line will interfere as the cutting points approach to the common center line, and the nature and extent of this interference will be symmetrical and equal on both flanks of the thread as long as the form of the thread is symmetrical, such as in V-threads, U. S. form threads, Whitworth threads, Acme threads, etc. For buttress-formed threads the interference or side-cutting on each flank must be determined separately. As this last form of thread is seldom used only symmetrical threads will be considered.

The amount of interference depends upon the value of B and the pitch of the thread, or number of threads per inch, N. Thus

$$\text{Interference due to helix} = \frac{B}{360N} \qquad (4)$$

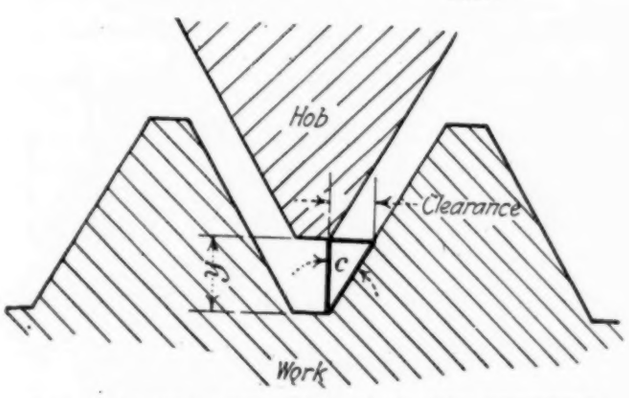


FIG. 2. DIAGRAM SHOWING CLEARANCE BETWEEN HOB AND WORK

If the included angle of the flanks of the thread is greater than zero—which is the case for all but square threads—as the cutting point of the side of the cutting tooth departs from the common center line of the hob and work a clearance develops between the cutting point on the hob and the flanks of the thread. The amount of this clearance depends upon the value of y and the included angle of the thread, and referring to Fig. 2,

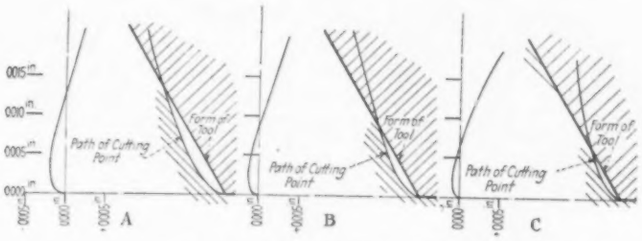


FIG. 3. CURVES SHOWING PATHS OF CUTTING POINT

it will be seen that its value, ignoring for the present the helix of the thread, may be expressed as:

$$\text{Clearance} = y \tan C \qquad (5)$$

The value of x is therefore found by subtracting the amount of interference given by equation (4) from the amount of clearance given to equation (5), or

$$x = y \tan C - \frac{B}{360N} \qquad (6)$$

As an example of the use of the above formulas we will assume that we wish to hob a thread which has a radius r of 0.5625 in. at the minor diameter with a hob whose radius R is 2.250 in. at its outside diameter with 4 threads per inch. A thread with a relatively large helix angle is taken as the first example in order to show the nature of the resulting side-cutting of a hob. The thread has an included angle of 60 deg., making $C = 30$ deg., and $N = 4$. The value of B is taken consecutively from 0 deg. which gives the following values for x and y:

For B =	0°	2°	3°	4°	5°	6°
x =	0	−0.00114	−0.00152	−0.00176	−0.00193	−0.00194
y =	0	0.00043	0.00097	0.00176	0.00267	0.00386

For B =	0°	7°	8°	10°	12°
x =	0	−0.00183	−0.00157	−0.00064	−0.00084
y =	0	0.00524	0.00691	0.01092	0.01589

The above values are plotted in Fig. 3-A at the left, and the actual path of the cutting point is shown at the right. These curves show the general form of the side-cutting of any point on the cutting face of a thread hob. This cutting face of the hob is made up of an infinite number of points. As the positions of these points vary the ratio between R and r varies, as also does the helix angle of the thread, and therefore each cutting point travels in a different form of path. Thus, in order to determine the resulting form of a thread cut with a hob it will be necessary to plot the paths of a few other points. A point 0.20 in. higher on the flank of the thread will therefore next be taken. This gives $R = 2.050$, and $r = 0.7625$, as before, $C = 30$ deg. and $N = 4$, and the values for x and y with these factors are as follows:

For B =	0°	1°	2°	3°	4°	5°
x =	0	−0.00061	−0.00102	−0.00126	−0.00129	−0.00117
y =	0	0.00015	0.00063	0.00143	0.00258	0.00398

For B =	0°	6°	7°	8°	9°
x =	0	−0.00084	−0.00032	−0.00041	−0.00136
y =	0	0.00577	0.00786	0.01034	0.01318

These values are plotted at the left in Fig. 3-B. The actual path of the cutting point is shown at the right.

A third point 0.40 in. above the bottom of the thread will next be taken. This point is beyond the top of the thread, but it is taken to accentuate the distortion developed by hobbing. In this case $R = 1.85$, $r =$ 0.9625, $C = 30$ deg., and $N = 4$. The values for x and y with these factors are as follows:

For $B =$	0°	1°	2°	3°	4°	5°	6°	7°
$x =$	0	−0.00057	−0.00088	−0.00093	−0.00073	−0.00026	−0.00049	−0.00151
$y =$	0	0.00022	0.00087	0.00199	0.00354	0.00566	0.00807	0.01104

The above values are plotted at the left in Fig. 3-C. The actual path of the cutting point is shown at the right.

In order to show more clearly the nature of the side-cutting of hobs the curve in Fig. 4 is plotted in an exaggerated form with the intervals along the y-axis equal to 0.001 in., and those along the x-axis equal to 0.0001 in. The curves shown in Figs. 3-A, 3-B and 3-C are plotted to this scale and brought together proportionately; that is, the origins of these curves are spaced equally from the bottom, but these spaces are not to scale. This distorts still further the exact shape of the curve, but its general properties are correct.

This curve shows the general nature of the distortion in the form of a thread which is caused by the side-cutting of the hob. It will be noted that it is a double curve, the lower part (below the line A–A) being developed by the bottom corner of the hole tooth, while the upper part (above the line A–A) is developed by the overlapping paths of successive cutting points on the cutting face of the hob. It is evident that the distortion shown at the bottom of the curve is inevitable and no correction in the form of the hob is possible that will eliminate it. It can be reduced in many cases, however, by making the hob smaller in diameter, as will be discussed later. On the other hand, the distortion shown in the upper part of the curve can be eliminated by changing the form of the cutting edge on the hob.

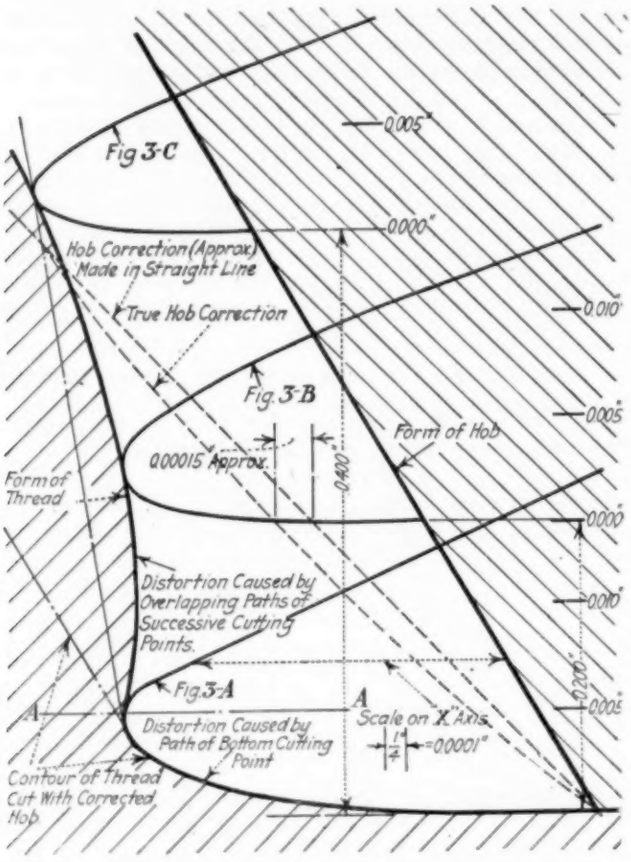


FIG. 4. CURVES SHOWING SHAPE OF CUTTING PATH

Fig. 5 shows graphically the successive positions of the cutting edge of the hob in relation to the thread, illustrating just how the distorted form develops. The line 1–1 shows the flank of the hob tooth when the cutting edge is on the common center line of the hob and the work; 2–2 shows this edge as it is about to leave the upper part of the flank of the thread; 3–3 and 4–4 are finishing intermediate points of the flank; 5–5 shows the cutting edge at the point where the side-cutting is greatest; and 6–6, 7–7 and 8–8 show it in successive positions after it has finished cutting.

Referring again to Fig. 4, two dotted lines will be seen, one marked "Hob Correction (approx.) Made in a Straight Line," while the other is marked "True Hob Correction." These represent the contour of the correction. In order to maintain the proper width of thread space the thickness of the hob teeth must be reduced.

The correction of the hob is determined in the following manner: The greatest amount of side-cutting is done by the bottom corner of the hob. In the foregoing example the tabulation shows 0.00194 in. when $B = 6$ deg. This is not necessarily the exact maximum. If a closer value is required the tabulations must be made with increments of B of smaller amounts. Tabulations as shown, however, will be correct to the fourth decimal place, which is sufficiently accurate for most purposes.

If the tooth of the hob be narrowed at each point of the cutting edge by the amount which it side-cuts the thread form the contour of the thread above the line A–A in Fig. 4 will be correct. To do this exactly would require a curved form on the hob. For example, the maximum side-cutting at the top of the thread form shown in Fig. 4 amounts to 0.00093 in. when $B =$ 3 deg., while at the middle point it amounts to 0.00129 in. when $B = 4$ deg. If the bottom of the hob tooth is reduced 0.00194 in. on a side and the upper point is reduced 0.00093 in. on a side and the two points

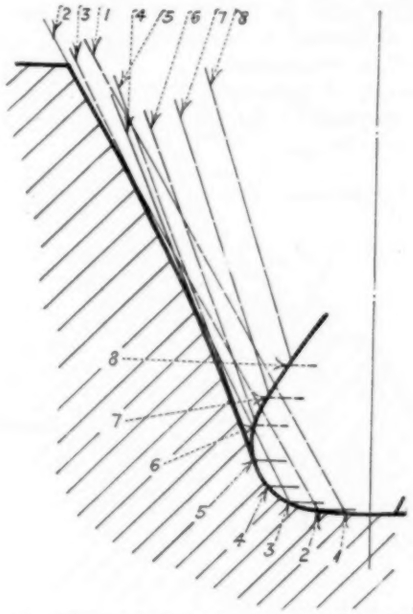


FIG. 5. DIAGRAM SHOWING POSITIONS OF CUTTING EDGE OF HOB IN RELATION TO THREAD

are connected by a straight line the middle point will be reduced but 0.00129 in. In this case a correction in a straight line will introduce an error of about 0.00015 in. In most cases it will be found that the correction in a straight line will be sufficiently accurate as the resulting error will be negligible.

Fig. 6-A represents the form of a thread cut with a hob having the form of the cutting edges identical with the true form of the thread. In this figure,

C = half included angle of thread;
F = width of flat of thread at the root or minor diameter;
r_1 = largest value of r employed (radius of major diameter);
r_2 = smallest value of r employed (radius of minor diameter);
x_1 = maximum minus value of x for r_1;
x_2 = maximum minus value of x for r_2;
$(r_1 - r_2)$ = depth of thread;
$2(r_1 - r_2) \tan C + F$ = width of space at major diameter (outside).

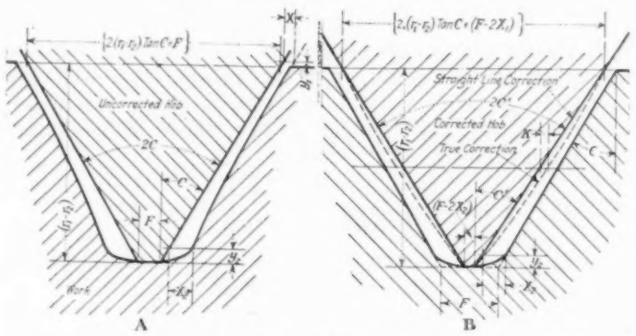


FIG. 6. FORM OF EXTERNAL THREAD CUT WITH UNCORRECTED AND CORRECTED HOB

Fig. 6-B illustrates a corrected hob and the form of thread cut with it. In this figure

$F - 2x_2$ = width of flat at bottom of hob form;
$2(r_1 - r_2) \tan C + (F - 2x_1)$ = thickness of hob form at top;
C' = half the included angle of corrected hob.

If the cutting edge of the hob is kept as a straight line the tangent of half the included angle of the hob form will be equal to half the difference between the widths of hob form at the top and bottom divided by the height of the form. Using the values shown in Fig. 6-B we have the following:

$$\tan C' = \frac{2(r_1 - r_2)\tan C + (F - 2x_1) - (F - 2x_2)}{2(r_1 - r_2)}$$

$$\tan C' = \tan C + \frac{F - 2x_1 - F + 2x_2}{2(r_1 - r_2)}$$

$$\tan C' = \tan C + \frac{x_2 - x_1}{r_1 - r_2} \qquad (7)$$

It will be seen from equation (7) and also from the figures that a corrected hob will have a greater included angle than the thread itself; or, in other words, the included angle of a hobbed thread on a screw or male-threaded part will be less than the included angle of the hob.

The dotted line in Fig. 6-B represents the true correction of the hob. Also in this figure,

r_3 = value of r at middle of thread flank (or at pitch diameter);
x_3 = maximum minus value of x for r_3;
K = difference at r_3 between straight-line correction on hob and true correction;

$$\frac{x_2 - x_1}{2} + x_1 = \frac{x_2 - x_1 + 2x_1}{2} = \frac{x_2 + x_1}{2}$$

= correction at r_3 when hob form remains a straight line;

$$K = \frac{x_1 + x_2 - x_3}{2} \qquad (8)$$

If the rounding or fillet at the bottom of the thread as shown in Fig. 6-B is objectionable the point of the hob may be extended by an amount about equal to y_3, provided that such an undercut is permissible. By so doing an almost theoretically perfect thread form will be secured. This condition is illustrated in Fig. 7. Theoretically, the point should extend slightly more than y_3, as at this point r becomes smaller and R becomes larger than the values of r_1 and R_1. Referring to equation (3), this increase in the value of R will increase the value of r'. Referring to equation (1), this increase in the value of r' and the decrease in the value of r will increase the value of y. But for all practical purposes an extension on the point of the hob of the nearest even dimension to y_3 will usually be sufficiently accurate. On standard threads cut with hobs the resulting error will be in fifth or sixth decimal place.

For the purpose of simplifying calculations Tables I and II have been developed. These tables are based on work whose radius is 1.000. The value of $B/360$ is given opposite varying values of B and values of y/r are given for different values of r/R. In order to use the tables the value of r/R must first be determined, then the value of y/r is multiplied by the radius

TABLE I. VALUES OF RATIO y/r FOR r/R = 0.05 TO 0.45 (EXTERNAL THREADS)

		Ratio r/R of Radius of Deepest Point on Work to Radius of Cutting Point on Hob														
B	$B/360°$	0.05	0.06	0.07	0.08	0.09	0.10	0.12	0.14	0.16	0.18	0.20	0.25	0.30	0.35	0.40	0.45
0° 30′	0.001389	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00005	0.00005	0.00005	0.00005	0.00005
1°	0.002778	0.00015	0.00015	0.00015	0.00015	0.00016	0.00016	0.00016	0.00017	0.00017	0.00018	0.00018	0.00019	0.00019	0.00020	0.00021	0.00022
1° 30′	0.004167	0.00034	0.00034	0.00035	0.00035	0.00036	0.00037	0.00038	0.00039	0.00040	0.00041	0.00042	0.00042	0.00043	0.00043	0.00044	0.00044
2°	0.005556	0.00064	0.00065	0.00066	0.00067	0.00068	0.00069	0.00070	0.00071	0.00073	0.00074	0.00075	0.00077	0.00079	0.00082	0.00085	0.00088
2° 30′	0.006944	0.00100	0.00101	0.00102	0.00103	0.00104	0.00105	0.00107	0.00109	0.00111	0.00113	0.00115	0.00118	0.00121	0.00124	0.00128	0.00132
3°	0.008333	0.00148	0.00149	0.00150	0.00151	0.00152	0.00153	0.00156	0.00159	0.00161	0.00164	0.00167	0.00173	0.00179	0.00185	0.00191	0.00197
3° 30′	0.009722	0.00204	0.00205	0.00206	0.00207	0.00208	0.00209	0.00215	0.00220	0.00226	0.00231	0.00237	0.00242	0.00248	0.00254	0.00260	0.00266
4°	0.011111	0.00269	0.00270	0.00271	0.00272	0.00273	0.00274	0.00279	0.00285	0.00291	0.00298	0.00304	0.00313	0.00323	0.00333	0.00343	0.00353
4° 30′	0.012500	0.00328	0.00329	0.00330	0.00331	0.00332	0.00333	0.00340	0.00347	0.00355	0.00362	0.00369	0.00383	0.00397	0.00411	0.00425	0.00440
5°	0.013889	0.00406	0.00407	0.00408	0.00409	0.00410	0.00411	0.00420	0.00429	0.00438	0.00447	0.00456	0.00475	0.00494	0.00513	0.00532	0.00551
6°	0.016667	0.00598	0.00599	0.00601	0.00602	0.00604	0.00605	0.00616	0.00626	0.00637	0.00647	0.00658	0.00686	0.00714	0.00742	0.00770	0.00798
7°	0.019444	0.00822	0.00824	0.00826	0.00827	0.00829	0.00831	0.00843	0.00856	0.00868	0.00881	0.00893	0.00932	0.00971	0.01011	0.01051	0.01091
8°	0.022222	0.01068	0.01072	0.01077	0.01081	0.01086	0.01090	0.01107	0.01125	0.01142	0.01160	0.01177	0.01228	0.01279	0.01330	0.01382	0.01434
9°	0.025000	0.01342	0.01350	0.01358	0.01367	0.01375	0.01383	0.01406	0.01429	0.01453	0.01476	0.01499	0.01564	0.01629	0.01695	0.01761	0.01827
10°	0.027778	0.01646	0.01659	0.01672	0.01685	0.01698	0.01711	0.01741	0.01771	0.01800	0.01830	0.01860	0.01942	0.02024	0.02106	0.02188	0.02270
11°	0.030556	0.01984	0.02002	0.02020	0.02039	0.02057	0.02075	0.02112	0.02149	0.02187	0.02224	0.02261	0.02361	0.02461	0.02562	0.02663	0.02764
12°	0.033333	0.02357	0.02380	0.02405	0.02428	0.02452	0.02476	0.02521	0.02567	0.02612	0.02658	0.02703	0.02824	0.02945	0.03067	0.03189	0.03311
13°	0.036111	0.02766	0.02796	0.02826	0.02855	0.02885	0.02915	0.02969	0.03024	0.03078	0.03133	0.03187	0.03331	0.03476	0.03621	0.03766	0.03911
14°	0.038889	0.03212	0.03248	0.03284	0.03321	0.03357	0.03393	0.03457	0.03521	0.03586	0.03650	0.03714	0.03884	0.04054	0.04224	0.04394	0.04565
15°	0.041667	0.03696	0.03739	0.03782	0.03825	0.03868	0.03911	0.03986	0.04061	0.04135	0.04210	0.04285	0.04483	0.04681	0.04879	0.05077	0.05275

TABLE II. VALUES OF y/r FOR r/R = 0.50 TO 2.00 (EXTERNAL THREADS)

B	$B/360°$	Ratio r/R 0.50	0.60	0.70	0.80	0.90	1.00	1.50	2.00
0° 30′	0.001389	0.00006	0.00006	0.00006	0.00007	0.00007	0.00008	0.00010	0.00012
40′	0.001852	0.00010	0.00011	0.00011	0.00012	0.00013	0.00014	0.00017	0.00021
50′	0.002315	0.00016	0.00017	0.00018	0.00019	0.00020	0.00022	0.00027	0.00032
1°	0.002778	0.00023	0.00024	0.00025	0.00026	0.00028	0.00030	0.00038	0.00046
1° 10′	0.003241	0.00027	0.00030	0.00033	0.00036	0.00039	0.00042	0.00053	0.00064
1° 20′	0.003704	0.00034	0.00038	0.00042	0.00046	0.00050	0.00055	0.00069	0.00083
1° 30′	0.004167	0.00045	0.00049	0.00054	0.00059	0.00064	0.00069	0.00086	0.00103
1° 40′	0.004630	0.00057	0.00062	0.00068	0.00074	0.00080	0.00086	0.00106	0.00126
1° 50′	0.005093	0.00073	0.00079	0.00085	0.00091	0.00097	0.00103	0.00127	0.00151
2°	0.005556	0.00091	0.00096	0.00102	0.00108	0.00114	0.00120	0.00151	0.00183
2° 30′	0.006944	0.00136	0.00146	0.00156	0.00167	0.00178	0.00189	0.00238	0.00287
3°	0.008333	0.00204	0.00217	0.00230	0.00244	0.00258	0.00272	0.00344	0.00416
3° 30′	0.009722	0.00272	0.00292	0.00312	0.00332	0.00352	0.00373	0.00469	0.00566
4°	0.011111	0.00363	0.00388	0.00413	0.00438	0.00463	0.00488	0.00614	0.00740
4° 30′	0.012500	0.00455	0.00488	0.00521	0.00554	0.00587	0.00620	0.00781	0.00943
5°	0.013889	0.00570	0.00609	0.00649	0.00689	0.00729	0.00769	0.00969	0.01169
6°	0.016667	0.00826	0.00884	0.00942	0.01000	0.01059	0.01118	0.01408	0.01701
7°	0.019444	0.01131	0.01212	0.01293	0.01374	0.01455	0.01537	0.01938	0.02343
8°	0.022222	0.01486	0.01594	0.01702	0.01810	0.01919	0.02028	0.02563	0.03107
9°	0.025000	0.01893	0.02033	0.02173	0.02313	0.02453	0.02593	0.03293	0.04002
10°	0.027778	0.02353	0.02529	0.02705	0.02881	0.03057	0.03233	0.04132	0.05041
11°	0.030556	0.02865	0.03082	0.03299	0.03516	0.03733	0.03951	0.05084	0.06247
12°	0.033333	0.03433	0.03696	0.03959	0.04222	0.04485	0.04748	0.06153	0.07650
13°	0.036111	0.04056	0.04370	0.04684	0.04998	0.05312	0.05627	0.07343	0.09258
14°	0.038889	0.04736	0.05106	0.05476	0.05847	0.06218	0.06589	0.08658	0.11147
15°	0.041667	0.05473	0.05905	0.06337	0.06770	0.07203	0.07636	0.10102	0.13380

of the work to obtain the value of y. The values of y/r may be obtained by interpolation when the value of r/R does not agree with any of those given. The values given under $B/360$ are divided by N and substituted in the equation $x = y \tan C - (B/360N)$ to obtain the value of x.

In order to illustrate the use of these tables and to determine the effect of varying the diameter of the hob the following three examples will be taken: An Acme thread, 5 threads per inch, one inch in outside diameter will be cut with hobs (1), one inch in diameter, (2) two inches in diameter, and (3) four inches in diameter. An Acme thread is selected because the smaller included angle of thread results in more side-cutting, thus making more pronounced the effect of varying the diameter of the hob. The depth of an Acme thread of this pitch is 0.110 in. The included angle is 29 deg.

The width of the flat at the root of the thread is 0.0689 in.

In the first example we have the following:

C = 14 deg. 30 min. $N = 5$

$r_1 = 0.500$ in. $R_1 = 0.390$ in.

$r_2 = 0.445$ in. $R_2 = 0.445$ in.

$r_3 = 0.390$ in. $R_3 = 0.500$ in.

This gives the following values for $\frac{r}{R}$:

$$\frac{r_1}{R_1} = \frac{0.500}{0.390} = 1.28 \qquad (a)$$

$$\frac{r_2}{R_2} = \frac{0.445}{0.445} = 1.00 \qquad (b)$$

$$\frac{r_3}{R_3} = \frac{0.390}{0.500} = 0.78 \qquad (c)$$

The values of x and y for the ratio (a) will first be computed. Referring to Table II, and interpolating between $r/R = 1.00$ and $r/R = 150$ for $r/R = 1.28$ gives the values for y/r. Dividing the values of $B/360$ in this same table by the value of $N(= 5)$ gives the values of $B/360N$. These values are as follows:

For B =	5°	6°	7°	8°
$\frac{y}{r}$ =	0.00881	0.01280	0.01762	0.02328
$\frac{B}{360N}$ =	0.002778	0.003333	0.003889	0.004444

Multiplying the values of y/r by $r(=0.500)$ gives the values of y. Substituting these values of y and the values of $B/360N$ in the equation $x = y \tan C - B/360N$, gives the values of x. These values thus obtained are as follows:

For B =	5°	6°	7°
x =	−0.001637	−0.001678	−0.001611
y =	0.004405	0.006400	0.008810

As soon as the maximum minus value of x is determined, it is unnecessary to proceed further.

In like manner the values of x and y for the ratio (b) are determined. These are as follows:

For B =	6°	7°	8°
y =	−0.002046	−0.002123	−0.002110
y =	0.004975	0.006830	0.009025

The values of x and y for ratio (c) are as follows:

For B =	7°	8°	9°	10°
x =	0.002519	−0.002641	−0.002694	−0.002671
y =	0.005296	0.006973	0.008912	0.011099

Using equation (7) the correction in the angle of the hob form is computed. The tabulations above give the following factors:

$r_1 = 0.500$ $x_2 = 0.002695$

$r_2 = 0.390$ $x_1 = 0.001678$

$r_1 - r_2 = 0.110$ $x_2 - x_1 = 0.001017$

$\tan C = \tan (14° 30,) = 0.25862$

Substituting these values in equation (7) we have

$$\tan C' = 0.25862 + \frac{0.001017}{0.110} = 0.26786$$

$$C' = 14° 59' 43''$$

$$2C' = 29° 59' 26''$$

In this case the difference between the angle of the hob and the angle of the work is 59 min. 26 sec.

The above correction is made in a straight line. Equation (8) will show the difference between this correction and the true correction at the middle of the flank; thus:

$$x_1 + x_2 = 0.004373$$

$$x_2 = 0.002123$$

$$K = \frac{x_1 + x_2}{2} - x_2 = \frac{0.004373}{2} - 0.002123 = 0.000064 \text{ in.}$$

This is negligible and can safely be ignored. In fact, it is much less than the probable error in the hob.

Referring to Fig. 6-B, the dimensions of the corrected hob and the thread produced will be as follows:

Work	Hob
$F = 0.0689$ in.	$F - 2x_2 = 0.0635$ in.
$2C = 29$	$2C' = 29° 59'$
$y_2 = 0.0089$	

This means that the corrected hob will cut an almost theoretically perfect thread form above the fillet which extends 0.0089 in. above the root of the thread. In an Acme thread a clearance of 0.010 in. is provided at this point, so that no further correction need be made. If desired, however, the point of the hob could be extended about 0.010 in., as shown in Fig. 7. In like manner the following values are determined in the second example:

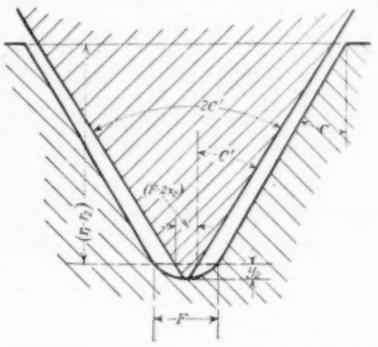


FIG. 7. FORM OF EXTERNAL THREAD CUT WITH POINT OF HOB EXTENDED

$2C' = 30° 0' 16''$ $\quad F - 2x_2 = 0.0619$ in.
$K = 0.000054$ in. $\quad y_2 = 0.012344$ in.

The values in the third example are as follows:

$2C' = 30° 0' 54''$ $\quad F - 2x_2 = 0.0608$ in.
$K = 0.000026$ in. $\quad y_2 = 0.014422$ in.

The following tabulation is made to show the various effects of varying the diameter of the hob. (Fig. 6-B.)

Hob. diam. =	1.000 in.	2.0000 in.	4.000 in.
x_2 =	0.002695	0.003475	0.004048
y_2 =	0.008912	0.012344	0.014422
$2C'$ =	29° 59' 26''	36° 0' 16''	30° 0' 54''
$F -$ $2x_2$ =	0.0635	0.0619	0.0608
K =	0.000064	0.000054	0.000026

From the above tabulation it will be seen that the amount of side-cutting at the bottom of the thread (x_2) increases as the diameter of the hob is increased. The height of the fillet at the bottom of the thread (y_2) also increases as the diameter of the hob increases, in fact, it increases about three times as much in this case as x_2. The included angle of the corrected hob ($2C'$) increases very slightly as the diameter of the hob increases. The width of the point of the corrected hob ($F - 2x_2$) varies less than 0.003 in. as the diameter of the hob is increased from 1 to 4 in. The dimension K in Fig. 6-B is reduced as the diameter of the hob increases.

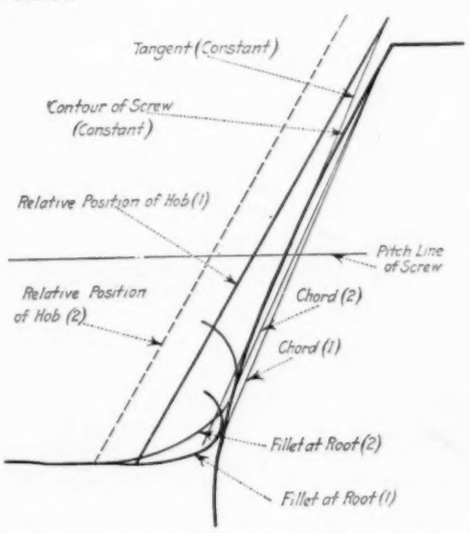


FIG. 8. DIAGRAM SHOWING CORRECTION FOR ANGLE

The correction for angle used in these solutions is a chordal correction. This shows a slight change in angle as the diameter of the hob varies. A geometrical solution of this side-cutting will show that except for the fillet at the root of the thread the profile is unchanged regardless of the diameter of the hob. Therefore, if the correction is taken as the tangent of the profile at the pitch line of the thread the angle C' will remain unchanged. This is shown in Fig. 8. The formulas for determining this angle are as follows:

Let $C = \frac{1}{2}$ included angle of thread;
$C' = \frac{1}{2}$ included angle of corrected hob;
$H =$ helix angle of thread at pitch line.

Then

$$\tan H = \frac{1}{\pi N \times \text{pitch diameter of thread}}$$

and $\tan^2 C' = \tan^2 C + \tan^2 H$.

It is evident from the above that if the form of the cutting edge of a hob of a certain diameter be corrected to cut a thread of a certain diameter and pitch a variation in the diameter of the hob of, say, 25 per cent will have but little effect on the form of the thread produced on the work.

In order to determine the effect of varying the diameter of the work the following tablation was made for a hob 2.0000 in. in diam. with Acme threads per inch.

Work diam. =	1.000 in.	2.000 in.	4.000 in.
x_2 =	0.003475	0.001161	0.000350
y_2 =	0.012344	0.004103	0.001512
$2C'$ =	30° 0' 16''	29° 14' 8''	29° 3' 6''
$F -$ $2x_2$ =	0.0619	0.0666	0.0682
K =	0.000054	0.000012	0.000003

The above tabulation shows that the amount of side-cutting at the bottom of the thread (x_2) decreases as the diameter of the work increases. The height of the fillet at the bottom of the thread (y^2) decreases as the diameter of the work increases. In this case it decreases about four times as much as x_2. The included angle of the corrected hob decreases quite rapidly as the diameter of the work increases. The width of the point of the corrected hob increases about 0.006 in. as the diameter of the work is increased from 1 in. to 4 in. The dimension K in Fig. 6-B decreases as the diameter of the work increases. In this case the amount of error introduced by a straight-line correction in the hob is in the fifth and sixth decimal place and is negligible.

It is evident, therefore, that a hob which is corrected for a certain diameter of work cannot be used on work which varies very much in diameter if accurate results are desired. The smaller the diameter of the work the more this condition is accentuated. This is due, in large measure, to the rapid increase of the helix angle on smaller diameters. On work of large diameters, where the helix angle is very small, little or no correction is required on the hob.

(To be continued in next week's issue.)

Making a Narrow Belt from a Wider One

BY JOHN A. GRILL

There is an error in the sketch accompanying the article under the above title on p. 823 of *American Machinist*. The wooden block between the vise jaws should be just large enough to let the belt slide through.

Made in the manner indicated by the sketch the belt would crowd over to the other jaw because there is nothing to prevent such action, especially if the knife blade is not parallel to the jaws. With the space between the jaws just wide enough to let the belt slip through it cannot get out of position.

Unnecessary Finish On Tools

BY JOHN A. HONEGGER

On page 365, Vol. 52, of the *American Machinist*, George H. Henrietta gives certain "Instructions to Toolmakers" regarding the finish on tools.

This "putting on of finishing touches" as one might say not only crops up in the jobbing shop but wherever there is a toolmaker who takes pride in the work he turns out. The writer also has had trouble in this respect and to eliminate it had a rubber stamp made as following:

NO FINISH EXCEPT ON WORKING SURFACES OR WHERE INDICATED

The letters were about $\frac{1}{8}$ in. high by $\frac{3}{4}$ in. wide and the whole stamp covered a space of about $1\frac{1}{2}$ x 6 in.

This notation was stamped on all detail and assembly drawings in two places: at the top of the sheet and to the left of the title. With this notation on the drawing it was strictly up to the workman or the jobbing shop. If at inspection the tool was found to have extra finish on it the producer had to explain.

Know What You Are Doing and Why You Are Doing It

BY JOHN A. GRILL

Under this title on p. 612 of *American Machinist* A. W. Forbes writes of setting a lathe tool below the center line of the work in order to make it cut better. I keep mine *above* the center. When I lower it the results are not so good.

Mr. Forbes says: "A way that leads to knowledge . . . is to break every rule and see what happens." Here is the way I broke one.

A casting mounted upon a mandrel in the lathe had a small boss projecting from its face at a distance of 8 in. from the center of the mandrel. I was facing off this boss, the tool cutting only when the projection came around, and was "cutting wind" for the remainder of each revolution. The tool was set about level with the lathe centers.

I had ground the tool in every way I could think of and had tried several different settings; had also tried running the lathe at various speeds, but the job persisted in chattering very disagreeably.

Along came a friend, who said: "Turn over your tool and run the lathe backward." I did this and it worked fine. I could run the lathe at a pretty good clip, there was no chatter, and I secured an excellent finish. What caused the work to act that way is beyond me unless it gets a better support by pulling up.

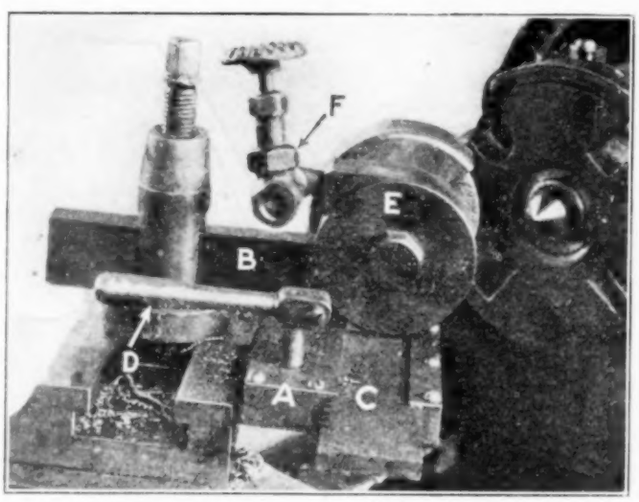
Grinding Device Run by an Air Turbine

BY J. V. HUNTER

The grinding device operated by an air turbine and shown in the illustration was built in the Decatur car shops of the Wabash Railroad Co. for grinding lathe centers and for handling little jobs of grinding that are sometimes done on a lathe. The lower frame *A* is attached to a shank *B*, that enables the whole device to be supported in the toolpost of a lathe.

The housing for the turbine and the wheel-arbor are mounted on the slide *C*, which enables them to be fed longitudinally by means of a rack and pinion drive operated by the lever *D*. The turbine consists of a cast brass housing *E* in which a common fan-type propeller is rotated by the air blast coming from a small nozzle and controlled by the valve *F*. The air hose is not shown connected. Exhaust from the turbine is through a number of small holes drilled in the left-hand side of the periphery of the housing. It will be noted that a small cast wheel-guard covers the upper side of the grinding wheel.

It may be noted in passing that air turbines of this character are usually heavy consumers of compressed air, and that therefore they cannot be looked upon as providing an efficient method of propulsion.



AIR-TURBINE DRIVEN DEVICE FOR GRINDING LATHE CENTERS

Rockford Heavy-Duty Horizontal Boring Machine

SPECIAL CORRESPONDENCE

A boring and drilling machine intended chiefly for the work encountered in the automotive field, particularly the machining of crankcase bearings, is the subject of this paper. The tool has been developed from past designs of machines intended for the same purpose.

THE Rockford Drilling Machine Co., Rockford, Ill., builds a heavy-duty horizontal drilling and boring machine for automotive work. As early as 1916 it became apparent to the staff of the concern that there was a real demand for a single-purpose, heavy-duty, horizontal drilling and boring machine which could be highly standardized for automotive work and still would be flexible enough to meet almost any requirement. As a nucleus for the horizontal machine, the head of the Rockford vertical, heavy-duty drilling machine, complete with driving gears, spindle and feed mechanism, was used. This head can be shortened to give as little as 12-in. spindle travel or increased to give 40 in. In combination with different spindle designs and multi-spindle heads, it provides the means of rotating the bars and tools.

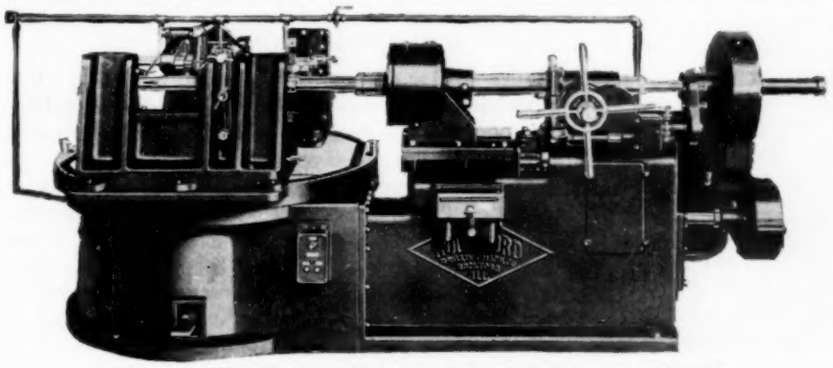


FIG. 1. ROCKFORD HEAVY-DUTY HORIZONTAL BORING MACHINE FOR AUTOMOTIVE WORK

The machine here described, see Fig. 1, is one of three built for the Olds Motor Works, Lansing, Mich., for boring crankshaft and camshaft bearings on an 8-cylinder motor. This machine is provided with two duplicate work-holding fixtures mounted on an indexing table. The loading station is at the rear of the machine and the operating station at the front.

While one fixture is being unloaded and loaded, and the bars and cutters changed at the loading station, the other fixture is at the operating station and the piece it holds is being bored. When the operation is complete, the operator disconnects the bars from the driving head and steps on the treadle projecting through the front side of the base. The treadle mechanism pulls the index pin and lifts the table on a large ball slightly off its bearing on the base. The table is then rotated 180 deg., bringing the new piece of work in line with the spindle and the finished one around to the loading station. This method of handling makes the operation almost continuous.

Care has been taken in designing the fixtures so as to provide adequate clamping devices of such form that the work will be held firmly, but not sprung out of shape. In this particular case, the lower surface of the crankcase is clamped against hardened-steel plates mounted on a vertical surface. This arrangement keeps the locating surfaces clean. Location of the crankcase is obtained by means of hardened dowels entering reamed holes in its lower surface. These dowels are relieved of all cutting strain by means of spring plungers, which are locked in position after the case is in position. The main drive may be either by motor or countershaft. When the countershaft drive is used, a three-step cone is provided, also a tight- and loose-pulley countershaft equipped with Hyatt roller bearings. The motor shown mounted on the back of the machine in Fig. 2, is directly connected through gears without the use of flexible couplings or chains. Interchangeable gears are provided for speed changes with both types of drive.

Feed changes are four in number, the mechanism being incorporated in a feed box employing a movable driving-key. The feeds are placed in geometric ratio, with a factor of 1.5. A forward and reverse feed mechanism can also be provided. All bearings on both the drive and feed mechanisms are bronze-bushed. The base is of heavy box section, well ribbed, and is bolted together in such a manner as to facilitate changes in design without many pattern changes. The feed and drive mechanisms are completely mounted on one base section and the fixtures holding the work are mounted on the other section.

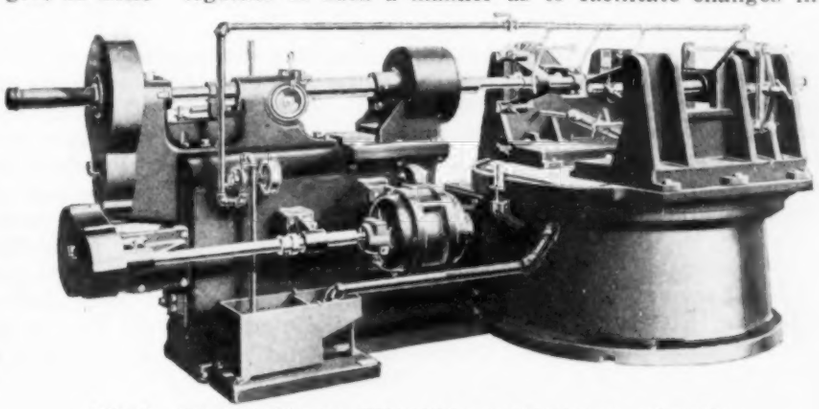


FIG. 2. REAR VIEW OF ROCKFORD HORIZONTAL BORING MACHINE, SHOWING MOTOR AND FIXTURES

The machine bores simultaneously two crankshaft bearings 2 $\frac{7}{16}$ in. diameter by 2 $\frac{3}{4}$ and 2 $\frac{1}{8}$ in. long, respec-

tively, and three camshaft bearings in aluminum at a cutting speed of 200 ft. per minute and 0.010 in. feed per revolution of the spindle. The operations are divided into rough boring, facing and finish boring, a machine being provided for each operation. All these operations with the addition of counterboring, drilling, etc., may be combined on one machine, if the rate of production does not warrant more equipment.

The Equipment

The equipment for the work includes a complete set of Kelly Reamer Co.'s bars and cutters. A floating drive is used between the bars and spindles, so that the accuracy of the work depends upon the fixture alone. Liner bushings are provided in all cases, so that it should be easy to re-align the boring-bar guides in case of wear.

It is said that the machines are adaptable to a wide range of work and can be easily arranged to take care of holes from 1 in. in diameter in steel to 12 in. in cast iron and aluminum. They are rated at a capacity of 2½ in. in diameter when drilling from the solid in steel.

The machines have been adapted to different sorts of work, such as crankcase and transmission-case boring for tractors, trucks and passengers cars, including facing and counterboring, cylinder boring for tractors, drilling and reaming, rear-axle drilling and boring, gun-carriage work, centering of large forgings, milling pads on crankcases, and double-end drilling.

Making Thrift Seem More Worth While

By FRANK H. WILLIAMS

It is not very generally realized by plant executives that thrift among employees is very closely allied with contentment on the part of employees, and with increased production. But such is the case as any executive can very readily determine for himself by investigating conditions among employees who are saving on a systematic basis, and among employees who are always "only a month ahead of the poor house."

IF A PLANT executive will undertake an investigation in an impartial frame of mind and if his investigation is thorough and unbiased, he will find—in the great majority of cases—that the restless employees are those who spend everything they make and that the substantial employees, upon whom he has to depend in the long run for the great bulk of production, are those who are laying up something for a rainy day.

And the exectuive will also find that among the more substantial employees there is a very clear appreciation of just what thrift is and an almost enthusiastic commendation of any worth while steps taken by the plants where they are employed to help them in their savings.

An employee who saves is taking the first step toward the owning of property—his own home, first of all. And employees who own their own homes or any sort of property are always the ones who are anxious for stabilized working conditions and who are generally leaders in all fights against bolshevism and kindred evils.

Consequently, it is very evident that the cultivation of thrift among employees of any plant is a mighty good thing for that plant in the way of stabilizing conditions and in the way of increasing production.

And, just as it is a good thing for any plant to have employees who are thrifty, so is it an infinitely better thing for the plant to create a feeling of co-operation between employer and employees by doing something definite and specific to help the employees with their savings. And if the employer in helping the employees does more in the way of help than would be done by any outsiders—such as banks, trust companies, home building companies, etc.,—then the confidence of the employees in the employer will be increased by just that much, and the spirit of co-operation between the two will be fostered by just that much extra help given employees beyond what an outsider would do for them.

Ways of Helping Employees to Save

Now there are a number of ways in which a plant can help employees in making savings, and in considering these plans it is best to first consider the usual ways in which employees save money.

One of the newest and most popular methods of saving is by means of "Christmas Clubs" in which a specified amount is paid every week for a period of fifty weeks at the end of which the bank or trust company conducting the club sends a check to the saver for the total amount of his savings plus a small amount of interest. While such clubs are ostensibly for the purpose of providing the savers with money for Christmas expenses, the fact is that the great majority of club members use the clubs simply as easy methods of saving money. Only a small percentage of the total volume of Christmas club checks is ever used for Christmas presents.

Life insurance is an established form of saving money among men employees.

A regular savings account is another method of saving money.

Purchase of stock in the employing company by means of deductions from the regular weekly wages, constitutes another method.

Purchase of Liberty bonds or other securities on the partial payment plan is another method, and the purchase of necessities on the partial payment plan, while not primarily a method of saving money, still is a method of increasing the employees' "working capital."

Employers who seek to help employees save money generally adopt some method in line with the foregoing, but because of familiarity with all these plans and because of the fact that most of the plans are almost hoary with age, the employees quite frequently do not respond to the conveniences offered them with as much enthusiasm as the company would like. And yet, if the employers tried out some new method of inducing thrift among the employees it is quite likely that the employees would almost entirely ignore it through fear that the new plan was designed primarily for "putting something over" on them.

The problems confronting employers who wish to

increase production and stability through increasing the thrift tendencies of employees are—How can thrift be made to seem more worth while? How can more employees be induced to save money? And how can those employees who are saving a little be induced to save more?

Most successful business enterprises when confronted with a business problem attack it from these angles:—1. What is the difficulty to be overcome? 2. What are the methods of overcoming the difficulty? 3. What results will be achieved by each of the plans suggested for solving the problem?

It would seem as though the same questions should be applied to this thrift proposition. Under this questioning we find that the answer to the first question brings out this interesting point—the difficulty to be overcome is an individual, personal difficulty with most of the employees. It is not a problem for mass settlement, but a problem for individual treatment. Under the second question we find that all of the methods suggested for saving money are good plans. Under the third question we find that the results to be achieved with one employee under the Christmas savings plan would be splendidly satisfactory, while with another employee the problem of life insurance is most important, so that aid in the purchase of life insurance would make the greatest hit with the latter employee. And so on with all the employees.

A Personal, Individual Problem

In the final analysis, the matter of thrift among employees is a personal, individual matter which demands personal, individual treatment. Just as general health rules are a good thing for the employees of any plant, so general thrift suggestions are a good thing for them. But to make some employee well who is suffering with fever, it is necessary to give that employee careful, thoughtful, personal and individual attention. And just in the same way it is necessary to give some impractical employee who sneers at thrift suggestions some careful, thoughtful, personal, individual attention if that employee is to be made to see the advantages of saving money; is to be helped in saving money in the manner which most appeals to him and is, through the building up of a personal thrift habit, to be made into a conscientious, contented and dependable employee.

A man's personal money affairs are just about as intimate and individual as anything can possibly be. The normal man resents the usual sort of probing and prying into his money affairs and he hates to be lumped in the class of "unthrifty" according to some general scheme of statistics. But he will open his heart and listen to reason when a friend in whom he trusts goes out of his way to show why thrift is well worth while.

So if you want to get the best results in building up thrift among the employees of your plant, get away from the idea that it is a mass problem. It isn't! It's an individual, personal problem. And the more individual and personal your treatment of it is, the more satisfactory will be the results.

Help-Wanted Advertisements

By H. M. Fitz

I was interested in the article in the *American Machinist*, page 892, by A. W. Forbes, entitled "Getting the Right Man Through the Help-Wanted Columns." Not being an authority on advertising, I can speak only from experience which indicates that what is said in the ad makes all the difference in quantity and quality of applicants.

Looking over the help-wanted column you see many ads that you know it is a case of taking a chance to answer. For instance, this is an actual ad word for word: "An all-round mechanic wanted, state age, married or single and salary expected—Address Box —." Can anyone tell to what vocation the above ad refers? It may be that of an all around boilermaker, carpenter, plumber, machinist, or any one of fifty other vocations. The age makes a difference and if a road job, a single man is preferable. Salary means a great deal because some people would rather work at half price at certain localities than at others. It is also a blind ad. Who? Where? As Mr. Forbes says, everybody out of a job will answer it. On that particular ad thirty-six men did take the chance but not one was employed because the ad failed to tell what was wanted, and as mechanics are not versed in mind reading, they all lost out; so did the author of the ad.

The position was vacant until this ad appeared: "A mechanic who is an all-around boilermaker, 35 to 50 years of age; some road work; single man preferred; 90c. per hour; address, H. H. & H. Co., Cleveland, Ohio." This ad cost twice as much as the other one and only four answers were received. One was employed and to tell the truth it was hard to pick that one, as no doubt any one of the four could have filled the job. It seems to me that the more definite the ad the better the results. It may not bring as many answers but those who do answer, will, no doubt, be nearer what is wanted.

"Blind" Ads

The writer some years ago answered the following ad: "An efficiency man wanted; good salary and prospects; give age, experience and reference in first letter. Box —." The reply I received was to this effect: "As you have had no coal mining experience we cannot use you." If the ad had mentioned "coal mining experience" I am sure it would have saved both of us time and trouble.

Another: "A production manager wanted by a first-class firm for special work on Sundays. Not oil, or land, or insurance, but good money assured." No, I did not answer this one for the reason that they take up too much space telling what it is not rather than tell in less words what it is. Also, it was "blind" and the deep secret will remain such so far as I am concerned.

A friend not long ago asked me to loan him $1,000 and showed me an ad in large type as follows: "Wanted: A production man to invest $1,000 with services; $20 a day and 10 per cent interest on your investment. Box —." I told him to answer it and find out who it was and all about it. He did so and got an answer from The ——— Transportation Co. advising him to call for personal interview as soon as possible on a matter of great importance to him. He therefore took a day off and went to the nearby town where the firm was located to cinch this wonderful opportunity. The next day I said "Jim, how did you come out? You want that money today?" "No," replied Jim, "he doesn't want a production manager; he wants a truck driver and tried to sell me a half interest in his two-truck route."

My experience has been that we can't expect to get the right man with the wrong ad any more than we can expect to catch brook trout with alligator bait—they may bite but you will never land them. A blind, indefinite ad may bring answers, but not results.

WHAT to READ —for the man in a hurry

Suggested by the Managing Editor

THERE is more of the automotive information this week in the leading article. Fred Colvin continues his series by writing on "Sheet-Metal Work for Automobiles." He enumerates several of the problems encountered in the sheet-metal branch of the industry and explains their solutions.

The highly poisonous cyanogen gas, which for the most part has hitherto been led as quickly as possible to the stack and allowed to dissipate, is now being controlled and caused to perform the work for which it is very effective—that of carburizing. "A New Method of Case-Hardening Steel" is the title of the paper by Wm. J. Merten, page 1169, in which the cyanogen gas method of carburizing is compared with present methods and a design of a regenerative cyanogen-gas carburizing furnace is shown.

What to read was not a difficult matter to decide two hundred years ago when books were few and magazines unheard of. It is far different now when so much reading matter is offered to pass the time pleasantly or profitably as the reader chooses. We are doing our utmost to make the "American Machinist" not only profitable but indispensable as a clearing house of ideas and news of the machinery world. This page is the editors' advertisement of their section of the paper. It gives the high spots

Entropy writes on "The Turn of the Tide," page 1170. He refers to the tide of ever-changing wages, that, as he sees it, is now an ebb-tide. "The law of supply and demand has never been out of operation for very long at a time," and "It takes two to make a fight, but only one to start a massacre," are two of Entropy's interesting statements.

We have recently had a report on the three-shift day in the steel industry which leads us to believe that we shall eventually get entirely away from the twelve-hour day in this, the last big industry, to give it up. At the same time some of the members of the steel industry have been leaders in another movement of importance—namely, education. Morris' seventh installment of his series on apprenticeship deals with schools at the Carnegie Steel Co.'s Pittsburgh plant. Page 1172.

An account of the meeting at which the report on the three-shift system in the steel industry was read, begins on page 1182. It was a joint meeting of the Management and Metropolitan Sections of the American Society of Mechanical Engineers, the New York section of the American Institute of Electrical Engineers and the Taylor Society. An abstract from the paper by Horace B. Drury is given.

Bruce W. Benedict, manager of shop laboratories, University of Illinois, has a very interesting article on "Helix Angle of Twist Drills," page 1175. He concludes, from experiments, that with the present design of flute, the most efficient high-speed milled twist drill has a helix angle of 35 deg. and that a drill with this helix angle consumes less power and generally has greater endurance than drills of other helix angles.

Many suggestions have been made as to how to increase production, satisfy workers, maintain morale and in general to make of the plant a big, happy family. Now comes C. B. Lister with advice that target shooting is an aid in industry. Page 1178.

The second part of "Early Traces of the Toothed Wheel" begins on page 1179. Manchester is the author. He takes up the development of gearing from the sixteenth century up to the time of Watt.

W. H. Chapman's paper, "Cylindrical Grinding in 1920," is concluded in this issue, page 1184. The first part appeared last week.

An interesting article is that on "The Cost of Labor and the Labor-Cost" by Elmer W. Leach, page 1188. Labor does not want its wages reduced, yet if selling price is lowered labor-cost must come down. Read the suggestions Mr. Leach has to offer to bring about adjustments to satisfy all concerned.

A paper which received much praise from engineers was "Side Cutting of Thread-Milling Hobs," by Earle Buckingham, of the Pratt & Whitney Co., read before the Machine Shop Section of the A. S. M. E. at the annual meeting last week. We understand that the preparation of this paper extended over a period of two years. Beginning on page 1192, we are publishing the part dealing with the hobbing of screws. The article will be concluded next week with the publication of the second part, dealing with the hobbing of internally threaded parts.

Our shop equipment news section is not large this week, but it should be borne in mind that the general article on the Rockford heavy-duty horizontal boring machine should be read in connection with that section.

CHRISTMAS—*the turning point*

THE CHRISTMAS SEASON is not one when the Spirit of Gloom is welcome. He and his chief-of-staff, General Discouragement, have had things very much their own way for too many weeks, but with the advent of the Spirit of Christmas their fortunes are doomed to a sudden reverse which may well be made the beginning of a complete rout of all their forces.

Just as the bright and confident spirit of the little force of Americans at Chateau Thiery stopped the onrush of the German hordes and revived the flagging courage of the jaded French and British veterans, so will the perennially youthful Christmas spirit defeat the forces of gloom and point the way for all of us to follow. Christmas alone cannot carry the day—we have all got to dig in and help. For Christmas is soon over and we may easily suffer a relapse from the confidence that means good business, to the doubt that spells depression.

It is not a baseless, Pollyanna-like optimism that we urge for there is plenty of reason to look forward to a prosperous year in American industry.

DON'T FORGET that we are blessed with better than average crops and that in the last analysis the buying power of the farmer determines the volume of the country's business. It is quite true that the reduction in prices of farm products means a considerable lowering of the farmer's income as compared to that of last year. But on the other hand the prices of the goods the farmer buys are bound to follow the drop in prices of the goods he produces and thus make his dollar of income buy more than it did last spring. It is too much to hope that an equalization of prices will be reached immediately. There is back-lash in the gears of trade which must be taken up. But the slow speed lever of deflation has been thrown in and it will not be many weeks before the driving impulse reaches the last gear in the train and the whole mechanism of business settles down to a steady pull that is more significant of solid success than the feverish racing along on high that has just ended.

Transportation difficulties are much less serious than they have been in years. While there is still much to be done to bring the railroads back to real efficiency there is good reason to believe that their affairs will be in such shape before summer that they can place orders for the tools they have long needed so badly.

THE MOST ENCOURAGING NEWS of the month is the formation of the Foreign Trade Financing Corporation at Chicago for the purpose of supplying the capital necessary to finance foreign trading under the provisions of the Edge law. The new corporation is a practical step in the right direction and while its limited capital will not go very far in financing the foreign trade of the United States, it will help and will serve to turn men's thoughts to the problems of equalizing exchange. The present exchange rate on American dollars all over the world represents a barrier that is more difficult to surmount than any protective tariff wall ever devised. Further steps will undoubtedly be taken during the coming year to remedy this evil.

So far as domestic finance is concerned we are in a better position than ever before. The Federal Reserve System has withstood inflation and deflation strains that would have wrecked the banking system of the last decade. Perhaps it has not always managed to care for everyone, but is that to be wondered at in the reconstruction period following the greatest war in history?

MANY OTHER FAVORABLE CONDITIONS and tendencies could be added but they have been discussed so many times that it seems useless to reiterate them. Most of our adversities have passed, or are passing, and it is therefore our present duty to recognize the fact and relegate it to the dead past.

The events of the last half of the year 1920 have disclosed a startling lack of morale among American business men. Is this a sudden development or the result of the softening effect of four years of easily-secured orders and unusual profits? Have we forgotten how to fight so soon? Granting that the intangible cohorts of gloom are harder to fight than many Germans, we have certainly not acquitted ourselves of late as we should. The picture of the richest nation in the world facing a promising future with dark foreboding must be one to excite the people of war-torn Europe to scornful derision.

LET'S BRACE UP! Worrying over the future never helped any one. On the contrary it is usually a contagious disease that spreads like a forest fire and consumes the courage of all who encounter the worrier. If you must worry, don't do it in public but present a bold front to the men you meet and open your intelligence to the basic economic facts that insure a golden future for all of us here in America.

Let the Christmas spirit into your soul to banish the shadows of past reverses and make sure of success in the new year by keeping it there.

We wish you all a very merry Christmas and a *busy* New Year.

SHOP EQUIPMENT NEWS

-Edited by-
S. A. HAND

SHOP EQUIPMENT • NEWS •
A weekly review of modern designs and • equipment •

Descriptions of shop equipment in this section constitute editorial service for which there is no charge. To be eligible for presentation, the article must not have been on the market more than six months and must not have been advertised in this or any previous issue. Owing to the news character of these descriptions it will be impossible to submit them to the manufacturer for approval.

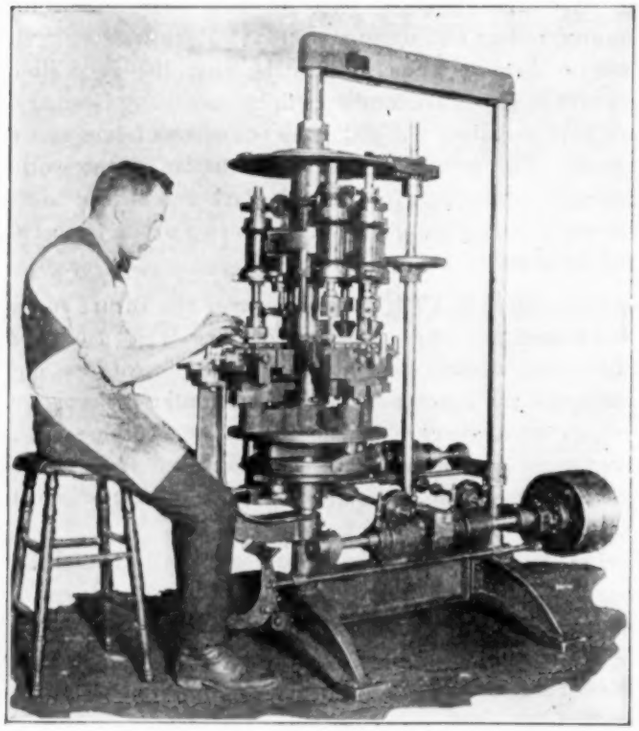
• CONDENSED • CLIPPING INDEX
A continuous record of modern designs • and equipment •

Jackson Vertical Automatic Chucking Machine

The Jackson vertical automatic chucking machine is manufactured by the Long-Henkel Manufacturing Co., Reading, Pa. It is intended for drilling, threading, turning, facing, etc., in the quantity production of small parts, such as nuts, pulleys, pipe fittings, battery terminals and electrical fixtures.

The machine is built in three types, the illustration showing one of the reciprocating kind and listed as "Type B." It has four duplex automatic chucking vises and three pairs of working spindles, being adapted chiefly to the class of work requiring drilling or boring, drilling to size, and then threading or tapping.

The chucking vises automatically eject the finished articles, and after the operator puts the unmachined parts in place the vises close automatically, thus relieving the operator of everything but the handling of the blank pieces and the observation of the work, which is constantly in his view. The machine has a positive drive throughout and is fully equipped with ball bearings.

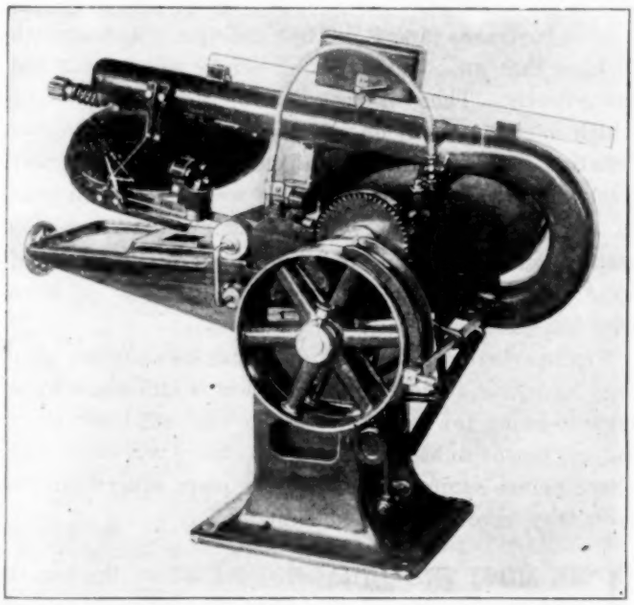


JACKSON "TYPE B" VERTICAL AUTOMATIC CHUCKING MACHINE

Quick-acting tool adjustments are provided, so as to facilitate setting up. The machine can be used to perform a number of operations at one time, the possibilities being limited chiefly by the number of spindles that may be used. As a threading or tapping machine for standard work, a magazine feeding appliance may be used. It is said that no particular skill is required of the operator. The floor space required is 3 x 5 ft., and the approximate weight is 1,450 lb. When boxed for export the weight is 1,750 lb. and the volume of the box is 1,050 cu.ft.

"Horizontal Junior" Metal Cutting Machine

The illustration shows the "Horizontal Junior" metal-cutting machine recently placed on the market by the Metal Saw and Machine Co., Inc., Springfield, Mass. The cutting is done by means of a bandsaw mounted almost horizontally on a frame that can be swung in a vertical plane in order to raise the saw. A capacity for work up to 4 x 4 in. is provided, the machine being a general-purpose, quantity-production tool. The cutting portion of the saw is held in position by means of roller guides, it being claimed that the cut made



"HORIZONTAL JUNIOR" METAL-CUTTING MACHINE

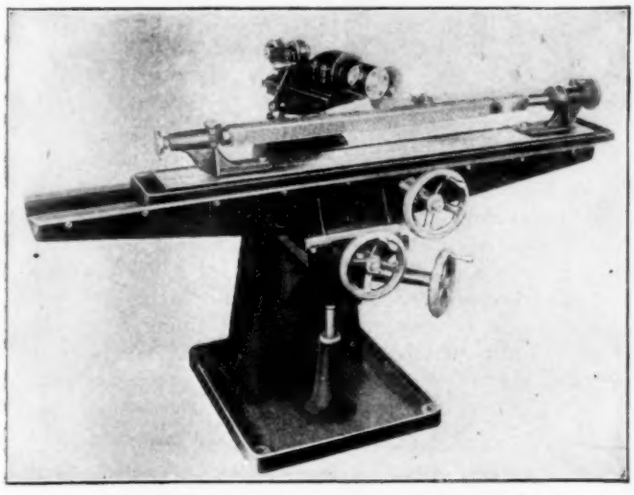
Specifications: Capacity, 4 x 4 in. Saw; length, 8 ft. 4 in.; width, $\frac{3}{4}$ in.; thickness, 0.032 in.; kerf, 0.047 in. Cutting speed, 120 ft. per minute. Speed of drive pulley, 250 r.p.m. Height, floor to table, 26$\frac{1}{4}$ in. Floor space, 2 ft. 8 in. x 4 ft. 6 in. Weight: net, 425 lb.; crated, 500 lb.; boxed for export, 625 lb. Export box, 54 x 32 x 40 in.

is very straight and square. A hand adjustment for securing the proper tension of the saw is provided on the head.

The feed of the saw is by gravity, the pressure of the cut being adjustable. It is claimed that the machine cuts a kerf only 0.047 in. wide, thus saving stock. The saws are said to give an average of 20 hours of service, although some give as high as 60 hours, the fact that all teeth of the saw do the same amount of cutting being pointed out. Saws can be furnished to suit special needs. The machine is equipped with a gear-driven pump to circulate the coolant when wet cutting is done.

Grinding Machine for Broaches

The illustration shows a grinding machine, designed for the single purpose of sharpening broaches, which has recently been placed on the market by the J. N. Lapointe Co., of New London, Conn., manufacturers of broaching machines and tools. This machine was designed and built a number of years ago for use in the Lapointe factory and because of a demand from many users of broaching tools for such a machine it is now being offered to the trade.



LAPOINTE BROACH GRINDING MACHINE

The machine consists of a column supporting a vertically adjustable knee, carrying a table for which both cross and longitudinal hand feeds are provided. Head- and foot-stocks, clamped to this table by the usual T-head bolt, take care of all broaches that can be held upon centers; while square broaches and keyway cutterbars may be clamped directly to the surface of the table. The head-stock is provided with an indexing mechanism for use when grinding spline broaches and also a live-center, belt driven from a three-speed auxiliary countershaft.

The capacity of the machine is ample to grind broaches 64 in. long and 8 in. in diameter.

The grinding wheel is carried on a spindle supported by a swiveling-head, which makes it possible to grind both the rake angle on the back of the broach teeth and to undercut the faces. The head swings on the column of the machine to any angle in the horizontal plane and so permits the grinding of teeth at any angle to the axis of the broach.

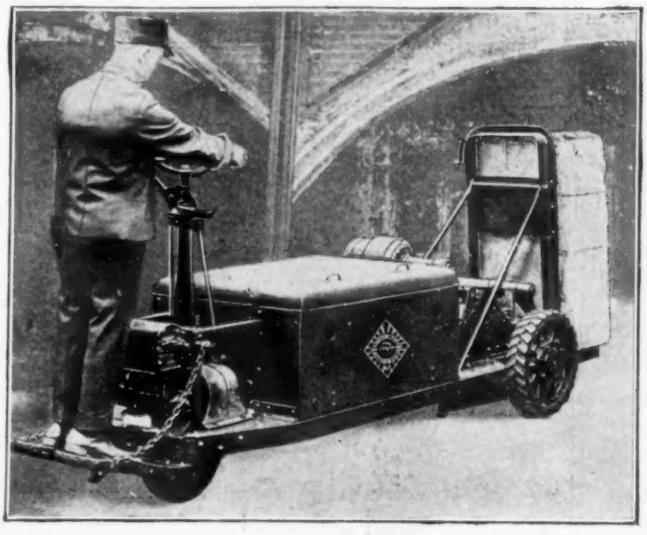
The grinding wheel spindle is belt driven from the main countershaft. A pair of idler pulleys change the direction of this belt to accommodate any angle to which the spindle may be set. The head is moved forward and back by a hand lever to bring the grinding wheel in contact with the broach teeth.

The machine occupies a floor space of 39 x 164 in.

Elwell-Parker Electric Malleable Pot Truck

The illustration shows an electric truck, intended for the handling of the pots used in the heating process necessary when making malleable castings, and recently placed on the market by the Elwell-Parker Electric Co., Cleveland, Ohio. The truck is intended for conveying the pots from the foundry and to the rattlers after the heating, as well as for charging the ovens or furnaces. The capacity of the truck is 4,000 lb., the pots being mounted on stools, so that the forks at the front end of the machine can fit underneath them.

Electricity is furnished by storage batteries inclosed in a steel case. It is claimed that from 150 to 200 complete trips and handling operations of the pots can be performed on one charging of the battery. A heavy frame of hot-riveted steel is used, and most of the parts of the truck are made of steel or of malleable iron. The machine has three wheels, the two at the carrying end doing the driving and the one at the operating end the steering, the truck being capable of turning in a radius equal to its wheel-base. The steered wheel is mounted in a spring cradle, in order to cushion shocks. Rubber tires are used when the ovens are charged at low temperature. For the charging of heated ovens a smooth steel wheel is used for steering and steel wheels having herringbone treads as the driving wheels.



ELECTRIC TRUCK FOR HANDLING MALLEABLE-POTS

The driving motor is totally enclosed and connected with the wheels by means of worm gearing and a differential. The axle is of the full-floating type, the housing carrying the weight of the truck. Double-row ball bearings 7½ in. in diameter are used in the wheels, and a contracting brake is provided between the motor and the differential.

The operator stands on two pedals and steers by means of an automobile-type wheel, the shaft of which is mounted in ball bearings. Depressing the left pedal releases the brake, while depressing the right one closes the circuit breaker, so that the truck may be run by

operating the controller. If the operator steps off the truck while it is moving, it automatically stops.

The toggle lifting mechanism is driven by a series motor through worm gearing and a special clutch. The pot can be lifted 6 in. from the floor, the mechanism automatically stopping at the end of the travel. By means of the switch, the forks and the pot may be stopped at any point in the up or down travel. The lifting mechanism is completely inclosed and runs in oil. The overall-length of the truck is 12 ft., and the weight with the battery is 3,600 lb.

Baird Truck-Frame Riveter

The illustration shows an adaptation of the "pinch bug" pneumatic riveter manufactured by the Baird Pneumatic Tool Co., Kansas City, Mo., especially for riveting industrial cars and truck frames. The device is adaptable to any steel fabrication within its range where the work is suspended from above and worked to completion from that position. The riveter itself is rigidly mounted on a stand.

The sliding valve is controlled by two pedals, thus leaving the hands of the operator free to guide the

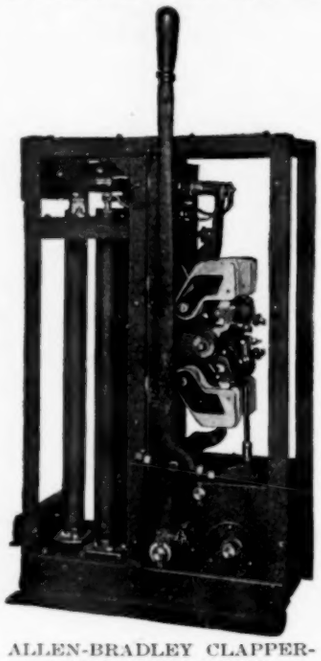
BAIRD TRUCK-FRAME RIVETER

work to its proper place. The riveter drives and heads ¾-in. rivets, hot. It occupies little space, being but 38 in. high and weighing approximately 600 lb.

Allen-Bradley Clapper-Type Controller

The Allen-Bradley Co., Milwaukee, Wis., has placed on the market a line of mill, crane and hoist controllers of the type shown in the illustration, to supplant its Types Q, R and S controllers. The new controller, made in sizes ranging from 1 to 150 hp., is known as the "clapper-type controller," primarily because all switching and contact-making are done with a clapper-switch contactor.

The controller is equipped with a graphite compression resistor, avoiding the use of grids or wire-wound resistors and the need of step contacts. All speed control is obtained by variation of the pressure upon the resistor column by means of the control lever. The controller is made for either direct or alternating current. Clapper contactors of the copper-to-copper, rolling type are used exclusively. The clapper switches, mounted inside the controller, are mechanically operated, and perform all switching in controllers up to 100 hp. in capacity. Larger controllers use external magnetic clapper switches actuated from a pilot switch within the controller. Switch cams positively open and close the switch clappers. A single lever gives full control in either direction without steps or jumps, and also actuates the clapper contactors.

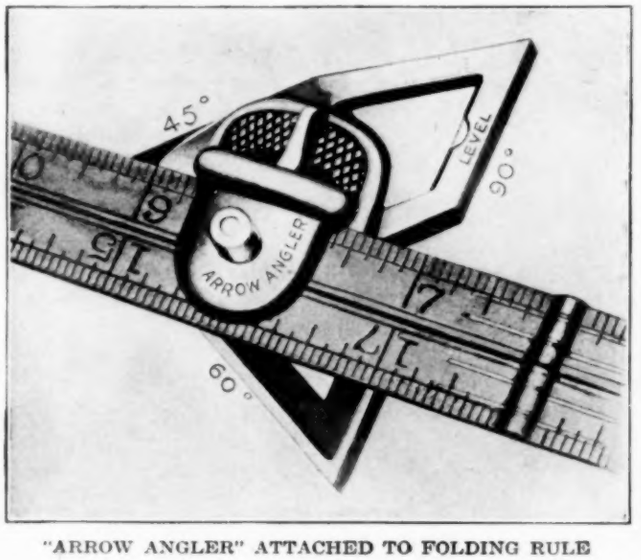


ALLEN-BRADLEY CLAPPER-TYPE CONTROLLER

The frame is constructed of steel, with pressed-steel inclosing covers. The controller is said to have advantages by virtue of the simple wiring and switch gear and the use of the compression resistor. Under-lever control gear, limit switch, brake connections and inclosing covers for the resistor compartment can be furnished.

"Arrow Angler"

Barnes & Irving, Inc., Syracuse, N. Y., has placed on the market the "Arrow Angler," shown in the accompanying illustration. The device is intended primarily for attachment to a straight-edge or a folding rule, being small enough to fit in the pocket conveniently. It it stated that it does not deface the rule and can be quickly attached and adjusted.



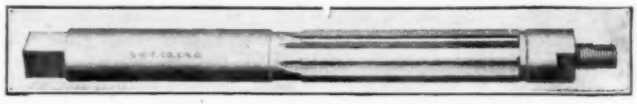
"ARROW ANGLER" ATTACHED TO FOLDING RULE

The device can be used for such purposes as a T-square, try-square, depth gage or scratch gage. It is said to form a quick means of laying out or finding angles, of bisecting angles, or of finding centers, diameters or tangents of circles. It is made of light-weight, non-corrosive metal.

"Rex" Expansion Hand Reamer

The illustration shows an expansion hand reamer which the Schellenback Hunt Co., Cincinnati, Ohio, is bringing out under the trade name of "Rex."

The reamers are split clear through the lengths of the teeth and are thus expanded at the starting ends

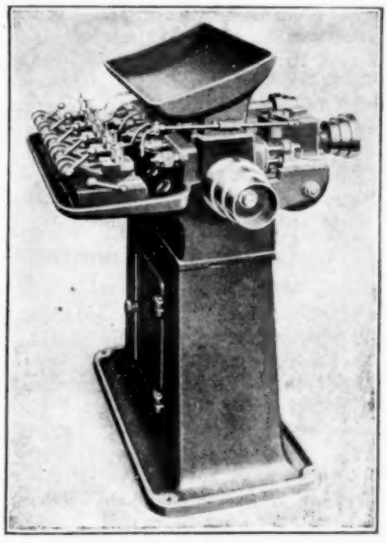


THE "REX" EXPANSION HAND REAMER

of the cutters and not in the center only. The expanding screw is taper threaded and engages tapped threads near the starting end of the reamer. The ends of the teeth are ground at an angle and are locked after adjustment by means of a beveled locknut as shown. The construction permits of a wide range of expansion of the cutters—0.025 in. or more is easily obtainable in a ½-in. reamer, with corresponding increase in the larger sizes. The adjusting screw and locknuts are hardened.

Changes in Detroit Semi-Automatic Five-Spindle Drilling Machine

The Detroit Machine Tool Co., 1487 St. Antoine St., Detroit, Mich., has made some changes in the design of its semi-automatic, multiple-spindle drilling machine. The machine is intended for the drilling of small holes in light work. The accompanying illustration shows how the large pan on the top of the machine for holding the work is tilted, so that the parts will slide to the lowest side and always be in convenient reach of the operator.



DETROIT SEMI-AUTOMATIC FIVE-SPINDLE DRILLING MACHINE

The chief new feature of the machine lies in the clutch in the feed mechanism contained in a housing on the right of the machine. The long, horizontal rod to be seen below the work tray is used to actuate a jaw clutch, so as to engage or disengage the worm drive in the feed. It is said that this feature is of advantage when the machine is being set up, as the spindles can be brought to their extreme forward positions in turn, and left there without stopping their rotation. The fixtures holding the work can then be moved to the position giving the proper depth of hole and clamped there. The feed can be instantly stopped if necessary, as when a drill sticks in a hard spot. By changing the belt on the cone pulleys on the right, feeds of 0.002, 0.004 and 0.006 in. per revolution can be obtained.

The type of work-holding fixture shown has a V-shaped jaw and a standard machine handle, although it is essentially the standard fixture No. 6100. It is intended for holding either hexagon or round stock from ¼ to 1⅛ in. in diameter, as when drilling cotter-pin holes in screws and bolts.

Restrictive Measures on the Shutdown of Industrial Plants in Germany

A law, fostered by the federal ministries of economics and labor, and bearing upon the closing down or breaking up of plants in Germany, has been passed by the preliminary national industrial parliament.

This law makes it compulsory for all firms contemplating a partial or entire break-up of their plants, as well as a temporary or permanent stoppage of operations, to bring such intention to the notice of the authorities whenever such measures would tend to result in the discharge of men to any undue extent. It covers all industrial plants—except those being the property of the Reich or of one of the federal states—including transportation service plants employing at least twenty workmen. From the date of filing the application, a period of suspension of four weeks in the case of a temporary shutdown and six weeks when contemplating breaking up will be compulsory, during which time no materials or legal changes likely to affect the proper management of the company will be permitted. In special cases an extension of three months will be granted when applying for a permit to break up.

To Prevent Unemployment

The period of suspension is principally intended to enable the demobilization authorities in charge of the execution of the regulations to take such steps as are deemed necessary in order to prevent a shutdown or breakup of plants; all such measures are to be taken in conjunction with the works management and the works council and, should circumstances require it, in collaboration with local and export organizations. A detailed statement giving instructions as to methods of procedure has been drafted for the commissioners, explaining the steps to be taken in dealing with the difficulties responsible for the proposed shutdown or breakup, as for instance, productive unemployment benefit, communal orders and contracts, etc. The commissioners entrusted with the proper execution of the regulations are advised not to regard each closing down of an establishment as a national or economic disaster, inasmuch as the coal famine may easily lead to temporary restrictions on production in the interest of an economical utilization of available stocks of raw material.

With a view of facilitating an efficient exploitation and utilization of available stocks and raw materials, the demobilization officials will be empowered to confiscate and expropriate all such stocks as soon as an application for a closing-down or breakup has been filed; and prompt measures will be taken to turn over the seized stocks—particularly coal—to works of national and economic importance.

The Machine-Tool Industry Abroad

Business Conditions in England

By OUR LONDON CORRESPONDENT

LONDON, Dec. 3, 1920.

THE general falling-away in trade here is quite apparent and newspapers (even those associated directly with the government) have been admitting the facts and discussing the remedy. "Heading for Bankruptcy" and similar phrases are being used.

The present rates of exchange prevent export trade and it is generally recognized that until the exchanges become more nearly level nothing like normal conditions can obtain in industry and commerce. A dwindling number of people are still against trading with Germany; those that are interested in a given branch of industry claim that Germany, in that particular direction, must be put out of competition or even permanently out of action. It may still be war, but it is not magnificent. And as an opinion it does not display much wisdom.

EXPORT TRADE NECESSARY TO PAY BRITAIN'S DEBT

In the selfish interests of Great Britain, trading between the nations must be fostered and encouraged. Contrary to pre-war conditions, Great Britain has a large external debt; only by exporting can this be repaid. It is therefore with some concern that people in England have noted the suggestion of increased—largely increased—import duties on the U. S. side.

COMPETITION WITH GERMANY

In engineering in particular, Great Britain may expect the strongest competition from Germany if that country only holds together. Great Britain has managed to cope with this competition up to the present time—unlike other countries—without erecting a tariff wall which, whether high or moderate, was designed to exclude. The government is, however, understood to have the tariff matter in hand. It is clear that at present Great Britain cannot compete on the European continent with Germany in many branches of engineering. Quite recently a British firm, and doubtless other firms, bidded to sell a supply of turbo-generating machinery to be sent to the continent of Europe. A German firm was successful—at a price one-third that of the English tender.

THE MACHINE-TOOL POSITION

The machine-tool position can hardly be said to grow more hopeful. Money is tight and no one is buying except for immediate requirements. In the Manchester district many firms have work in hand that will occupy them for several months. Cancellations are fairly frequent and although a number of inquiries have been received for tools of heavier types apparently nothing can be settled. Conditions are too shifting. The demand for small machine tools continues small, and several important shops in various parts of the kingdom are working short time, including half-time; discharges also can be recorded. One firm, relatively small and supplying machine tools that must be sold at about £300, has discharged practically the whole of its force; the cost of production per machine was found to be in the neighborhood of £1,200. One of three schemes of payment by results had been accepted by the workmen, but permission to work was refused by the local branch of the engineering trade union. The Armstrong-Whitworth concern shut down its locomotive works in the Newcastle district for a similar reason, though here it is understood that on seeing the firm's books the trade union officials have agreed to a piecework system of payment.

The small tool trade is in a very dull condition. Twist drills are without demand; few milling cutters are called for; one firm reports considerable activity on taps, dies, etc., but gages seem to be forgotten. It is stated that large stocks have been released by the government and that with present conditions it is useless to reduce prices. Price-maintenance associations have been formed and, despite the declining demand, have increased prices with increase in the cost of steels. The remark above regarding twist drills applies to the high-speed steel variety. The case is different with carbon-teel drills; for these Great Britain has, in the past, depended on overseas supplies, largely German. The opportunity has not yet been taken completely to fill the place of the exported article. The position therefore of one well-known factory is that in high-speed steels a stock valued at £30,000 or more has steadily been accumulated, while orders for carbon steel drills are two months behind.

KEY INDUSTRIES LOBBYING FOR PROTECTION

The key-industry argument has been much worked of late and, unless all reports are false, much lobbying has been practiced in or near parliament to insure the support of that august body of "men who look as if they had done well out of the war." The magneto industry is, apparently with reason, fearing German competition and is crying aloud for protection. Here the fact has emerged that a price-maintenance association was formed; but, it is explained, this policy was given up fairly soon after the end of the war. The price maintenance scheme applied only while there was but one customer; namely, the nation. Other cries relate to pianos, steel billets, needles, tungsten and toys. The dye industry, too, is in the throes of the same kind of agitation. It has been admitted that so far Great Britain has not been able to produce certain dyes of quality equal to that of dyes from Germany. These dyes are essential for an important section of the export trade in textiles. Now although Great Britain may refuse to accept the German dyes it is by no means certain that India and other textile competitors will follow this example; consequently these countries may easily wrest the trade from Lancashire, bringing about the downfall of the Lancashire textile industry and with it, the Lancashire man will add, the downfall of Great Britain. Textile machinery makers, by the way, continue busy and night shifts have been noted.

AUTOMOTIVE EXHIBITS

The series of commercial vehicle, pleasure vehicle and cycle and motor-cycle exhibitions held at Olympia, London, W., comes to an end this week. To judge by appearances the motor-cycle show may possibly be in proportion most effective as a business-producer; though with strange unanimity the press asserted that the automobile industry was evidently on its feet again, and, as the result of the recent show, has been in receipt of large firm orders. Indeed it has been stated that orders accepted at Olympia amounted to £50,000,000. Having appeared in print, this statement must be true. Nevertheless rumors of troubles and liquidation are again to be heard—a petition in connection with a subsidiary firm has been postponed for a fortnight and one well-known small car, doubtless an exception, could at the time of the show be bought at two-thirds of its nominal price. It is pretty generally felt that the coming winter will see the elimination of a few smaller firms, but the industry as a whole will get through the troublous times with some success.

The French motor-car industry is in a worse position. To raise the wind, one well-known firm has been hawking certain of their machine tools about London; again, a vessel was chartered and loaded with motor cars, to call at Far Eastern ports until the cargo had been sold. The motor boat show, provisionally arranged for next spring, is to be abandoned.

Labor Conditions

Despite threats of a complete closedown of electric generating stations, for the time being peace reigns in industrial circles; or rather did until a day or two ago, when shipyard joiners struck against reduction in wages to be enforced by the employers. Some time ago in order to put these workers on an equality with similar men engaged in house building they were given a bonus of 12s. a week. This is now to be deducted, the state of the shipbuilding industry being the reason offered. Belfast workers have agreed to the reduction. Then one of the leaders of the railwaymen has been stating that "there will be a big struggle yet ahead—a big fight in the next few months in this country." It will not be a question of hours and wages but of improvement in the status of the railwayman, who is not merely to be regarded as a hewer of wood and drawer of water, but as a contributor to efficient railway management. In short, a share in management is to be claimed, and this leads to the suggestion, not by any means novel, that a definite indication of the desires of the workers of Great Britain would be an advantage. Probably no one can make such a statement. Aims are diverse and the end, or approximate end, is not visualised.

Arthur Gleason has been studying us, and concludes that what is demanded includes a higher standard of living, more leisure, regulation of private profits, the distribution of wealth by state action (that is taxation), prevention of unemployment, further education, better housing, the nationalization of public services, etc. But it is fair to add that there is a fuller general ideal, or approach to an ideal, at the back of the minds of many now leading the working classes of Great Britain.

Labor's Desires

They desire complete co-operation between capital, labor and management, but decline to admit that capital as such is entitled to take all the fruits of industry after subsistance has been granted to producers, direct and indirect. The idea is that capital shall be entitled to interest at market rate, whatever this may be; apart from that, capital as such will have no rights. The wages and salaries of the managing, producing and distributing human elements will be the first charge and then, after payment of interest on capital, the surplus profits will be divided on some agreed plan between those who are actually engaged in the industry. As one outcome, the industry would itself be responsible for the maintenance of its unemployed members.

How in this particular detail the scheme would work can easily be seen in current experience in certain trades, for example, the building and printing trades, where entry into the trade is barred because the demand may cease in the course of a few years and unemployment ensue. If payment for unemployment came directly and solely from the pockets of the members of the industry they would, if sufficiently organized, be quite sure to see that the labor market in that particular direction was not overstocked. The scheme, in fact, in many respects is like that of the Whitley councils, and suffers from the root fallacy of much argument for protective tariffs. It is that each industry is self-contained and only self-regarding, whereas experience teaches that we are all brethren one of another. The war has tested many "isms"; in one direction or another all have been found wanting.

Mining Workers' Problems

According to preliminary statements, proceedings in connection with the settlement of mining workers' problems are proceeding fairly satisfactorily. A record tonnage was bought-up last week. Also preliminary questions regarding overtime and night work pay, etc., discussed between employers and employed in the engineering industry have been settled on lines that are almost generally acceptable, for the time being at least. But a decision regarding the claim for an increase of 6d. an hour has yet to be made; it is due in about a week. Many employers have of course long been definitely for fighting. On the other hand, many think that if by concessions troubles can be tided over a few months at a time it is all to the national gain. Some, indeed, suggest that the claim of the skilled engineers should be met, or that, on the other hand, the wages of certain unskilled workers, such as builders' laborers, should be reduced, there being no equity in the present position. For instance in Leeds the carrier of bricks and mortar may get 2s. 1d. an hour and the skilled engineering workman 1s. 10d. In the Clyde district the unskilled building laborer may get 2s. 4d. against 1s. 11d. an hour for the skilled joiner. Looking at the cost of building employers in the trades may, in fact, attempt reduction in the pay of their skilled workers, with unskilled labor at 25 per cent less than skilled.

Price Declines in Copper, Tin, Lead and Silver

A marked and fairly steady decline has of late been shown in the prices of copper, tin, lead and silver. Gold, too, has fallen within the last three weeks or so but appears again to be rising. Tin is stated to be something like 20 per cent below cost of production. Rubber also, which enters into some branches of engineering, is at a low ebb and proposals have been made for a complete stoppage of tapping; anything less than this is regarded as so much tinkering. At the London Iron and Steel Exchange recently little business was done, although it is thought that the present output of steel hardly covers current requirements. The marine side of engineering remains a good customer. Belgian billets are apparently obtainable at £8 a ton below home products, and at a meeting of the South Durham Steel and Iron Co., Viscount Furness, the chairman, mentioned as an illustration that steel joists can be imported from the continent at a cost of £17 a ton at English ports against £24 the price of home-produced joists. The South Durham Company, by the way, pays 25 per cent for the year.

Cooperite, understood to be the invention of H. S. Cooper of the Cooper Research Co., Cleveland, Ohio, has been demonstrated in the works of the Sheffield Mercantile Steel Co., Ltd., Sheffield, the rights in the material having been acquired by Zirconium Alloys Syndicate, Westminster, S. W. It is of course a non-ferrous material used for the casting of cutting tool; durability greater than that of high-speed steels has been claimed.

Situation of the Austrian Machine Industry

Special Correspondence

Reports from the various industrial centers would tend to show that the period of stagnation which has been obtaining for some time is gradually passing, and that there cannot be the slightest doubt that the commercial treaty recently concluded between Austria and Roumania bids fair to stimulate Austrian machinery export trade to a considerable extent. Under the terms of this agreement Austria will receive orders for the delivery of large quantities of machinery and apparatus. The automobile industry will come in for orders of 2,000 new cars, 1,000 trucks and 5,000 bicycles, and the shipbuilding industry for the construction of a number of Danube craft valued at 500 million kronen. Other orders which will be placed with Austrian industries are: pumps, valued at 300 million kronen; 100 million kronen worth of agricultural machines and implements; 4,000 sewing machines; 6,000 typewriters; 900 railroad trucks; 1,000 tank cars; 10 locomotives; and orders for railroad equipment, machinery, etc. will amount to 200 million kronen.

One of the most interesting features of the Austrian machine situation is the marked tendency for an "east-

ern orientation" which is easily explained by the foreign-exchange anomaly. Export of machinery and apparatus to Jugo-Slavia and Poland has shown a distinct increase of late, while the decision of the reparation committee to grant Austria credits for the purchase of raw materials is also partly responsible for the renewed export activity.

The locomotive industry reports very satisfactory business, many orders having been placed by Poland and Italy while negotiations for deliveries to France and Russia are still pending. Interested quarters are fairly confident that negotiations with France will be carried to a successful end before long, but deliveries for Russia will not be for some time owing to technical difficulties quite apart from the question of payments. The orders placed by the government for the state railroad are nearly completed but repeat orders both from the state railroads and private companies will probably be placed soon. A number of freight locomotives have been ordered by Roumania.

The government ordnance works at Vienna, Woellersdorf and Fischamend which were turning out munition, guns, flying machines, machine equipment and other kinds of war material, have now almost completed their reconstruction for the production of peace products. By far the greatest part of the new products are agricultural machines and implements, such as plows, harrows, cultivators, threshers, etc. The daily output of the various works amounts to 200 plows, 100 cultivators, 50 threshing machines and 50 straw choppers. A large part of the output has been contracted for by both inland and foreign concerns and such has been the demand of late that some of the works are working overtime and nightshifts. This will hardly come as a surprise to anyone making a closer study of the situation. Most of the materials used at the ordnance works in the manufacture of new machines and implements are so-called "demobilization materials," that is, parts or materials gained in the compulsory destruction of munitions or other kinds of war material. This costs the state practically nothing while enabling the works to produce at a lower cost than private companies, and it goes without saying that the latter feel rather sore on that point, though the fact should not be forgotten that the lower cost prices of the government works are but a temporary feature and an adjustment of prices will have to come about the moment the demobilization materials are exhausted. Moreover, latest information shows that the sale of ordnance works to private industry is contemplated, it being stated that the annual deficit amounts to 20 to 25 million kronen, owing to works serving as objects for socialization experiments.

German Machine Trade Conditions

BY OUR BERLIN CORRESPONDENT

BERLIN, Nov. 15, 1920.

BUSINESS is still suffering under the general depression which set in last spring. The reports of manufacturers' associations and of stock companies are full of complaints as regards business. Employment has decreased almost everywhere; only about 50 per cent of the machine-building works are running a 48-hr. week. The others have reduced working hours anywhere down to sixteen hours per week. Few factories, however, have shut down completely, as a business improvement was expected this fall. Although a slight revival has set in during the last two months, evidently caused by the further sinking of the German currency, it is not marked enough to give a more optimistic outlook. In general the hopes for a return of fair business have been doomed to disappointment. It has been feared that under such conditions the retrenching of the industry will make quick progress and cause a large number of works to close, thus increasing the already swelled number of unemployed. In anticipation of such intentions the government has issued regulations which are making it difficult for factory owners to shut down their factories without showing good reasons. By these regulations workshops employing more than ten men have to send in a notification at least four weeks in advance together with a statement explaining their reasons for wishing to shut down. The government has the right to investigate the soundness of reasons given and will undertake eventually to procure employment for the works thus affected. These regulations are meant to put a stop to the wanton shutting down of factories, which it is expected would otherwise prevail.

This measure is strongly resented by the factory owners, who can say for themselves that no owner would shut down so long as there is the possibility of keeping the works going. In fact there is a great reticence in this respect which is due to the common fear that no one going out of business temporarily knows nowadays when and whether at all he can resume activities.

The pessimistic view prevailing is not only caused by the persistent dullness of the inland market, but more so by the reports coming in from other countries, which show that the business depression is general and that little can be expected from the foreign market. The failure of the fairs held in Leipzig in August and in Frankfurt in October of this year strengthened this view. There was little German business, and foreign buyers, although a fair number of them attended, were doing nothing more than sampling, only few actual buyers coming forward. The German industry which had made great efforts to advertise these fairs and to spread the news that it could now offer firm prices and prompt delivery, giving at the same time indications of willingness to make prices more attractive, was shocked at the almost total absence of results. The belief is now general that a return to even normal market conditions will not set in until Europe is allowed to come to more settled conditions.

LACK OF EMPLOYMENT AND THE COAL SHORTAGE

The lack of employment is lately more and more ascribed to the coal shortage. Complaints in this direction are coming forward in ever-increasing numbers and have been substantiated by apparently incontrovertible facts.

All stages of manufacture, from steel works to manufacturers of finished articles, are said to be strongly affected by the lack of coal, specially steel mills and machine-building shops. Although such complaints come from all parts of the country, curiously enough most of them originate from the coal districts themselves. As a demonstration of the coal shortage the imports of American coal have been given large publicity, although the quantity imported is quite insignificant. It is a fact that the coal left at the disposal of the German industry, after deducting free exports and exports under the Spa treaty, is about 60 per cent of the pre-war supply and no doubt the German industry will find itself in a precarious position if business is in full swing once more, although a considerable part of the shortage is made up by strictest economy. In the present circumstances, however, statements ascribing the reduction of employment to the coal shortage are largely misleading. In this connection it will be remembered that the Spa treaty will soon run out and negotiations for a further settlement of deliveries are close at hand.

The steel works have lately decreased prices of raw material and semi-finished articles. Pig iron went from 2,140

to 1,770 Marks; bars from 2,840 to 2,440 Marks; plates over 2 in. from 3,595 to 3,090 Marks per ton; castings for machine parts, which have been up as far as 9 Marks per kilogram, can now be obtained for 5.50 to 6 Marks.

The above prices for bars and sheets are maximum prices. Actual sales have been concluded considerably lower—that is, 10 to 20 per cent—with the sole exception of ship-plate, which has still an exceedingly strong market. This reduction of prices is solely due to the necessity to meet market conditions and does not indicate a reduced production caused by the coal shortage.

It has been hoped that the reduction of the steel prices would set the prices moving on the downgrade along the whole line. The price question is considered the key to the whole business situation. The conviction has become general that prices have reached their utmost limit and have even surpassed it, thus causing the reaction which is now being felt so severely. So far as coal is concerned there is however no hope of such reduction. The coal miners have lately received an increase of wages and the mine owners have tried to raise prices accordingly. This has been stopped by the government on the strength of the enormous profits which are being made by the owners according to their own reports. While it can be expected that coal prices will remain stationary, their reduction is out of the question. Although the lower cost of raw material relieves the situation of the machine-building industry to a certain extent, the main relief is expected to come from the possibility to cut down the wages and other expenses. Such a possibility, however, seems very remote, as the living expenses show no decline and the workmen have lately given signs of a reviving unrest. It is more likely that wages and expenses will go up a step or two in the near future. A reduction of prices can therefore only be made by lowering the sale price independent of cost, which can be done to a considerable extent—at least in the case of the large works, judging from their excellent returns—and still leave a profit.

Some Large Profits

The Wotan-Werke in Leipzig for instance, a firm specializing in shapers, made in its business year, July, 1919, to June, 1920, a clear profit of 1,700,000 Marks, with a capital stock of 1,600,000 Marks; and Reineker in Chemnitz, with a capital of 6 million Marks, has just reported a rise of its gross profits from 3,700,000 Marks to 10,300,000 Marks, and a clear profit of over 3 millions, this being more than 50 per cent of its capital.

So far only the export prices have been reduced, but the inland prices have remained firm; whereby the difference between export and inland prices, which has been very large at the beginning of the year, has almost entirely disappeared.

Lately the whole front shows signs of weakening, beginning from the medium-sized and small works which are the hardest hit by the financial conditions and the tightness of money.

The Machine Tool Industry

It is reported from the machine-tool industry, which forms the largest section of the German machine-building industry and which, as the recognized forerunner of the fluctuations of the market, is closely watched from all sides, that the business stagnation continues, only the leading works having noticed slight improvements. The inland market is still in a sorry state, even the biggest users having restricted buying to immediate necessities. Inquiries are coming in more freely and it is seen from such inquiries that the large manufacturers are figuring on some new equipment, without however being able to come to the buying point. Only the state railways have lately been on the market for re-equipment of their workshops, which are still in the majority of cases stocked with machinery of obsolete type. The export market is dull. An improvement is hoped for from the decline of the German currency, which is now almost where it was last February, although it is not expected that anything like the rush of that time will come from foreign markets owing to the depressions prevailing there; especially as many dealers in the surrounding neutral countries are said to be still full up with machinery bought at that time.

Unemployment

There is hardly a shop in the country fully employed. The employment is, in the majority of cases, from 30 to 50 per cent, and only part of that is on full time, leaving an ever-increasing surplus. The big works have still been able to stand the financial strain, while the small works are making price concessions. Chemnitz lathes, which have been up to 20 Marks per kilogram, can now be bought for from 10 to 12 Marks. First-class lathes, which have been quoted at from 20 to 25 Marks per kilogram, are now freely offered at from 14 to 16 Marks per kilogram. Milling machines show stronger prices, on the average from 16 to 20 Marks per kilogram, grinding machines are quoted at 25 Marks per kilogram in the average; special machinery is considerably higher. Of foreign countries the best buyers of last spring like Holland, Sweden and Denmark have almost withdrawn from the market. Most orders are now coming from Spain, Italy and South America; even Australia is showing attention to the German market, which however has not materialized to actual business. Finland and other independent Eastern states are buying frequently. Soviet Russia, although very busy getting quotations, is not buying to a noticeable extent on account of the difficulties of payment.

Dealers keeping large stocks have lately been compelled to relieve their situation by selling below cost. This does not, however, apply to the dealers of high standing who have taken care not be burdened with extensive stock.

The Second-Hand Trade

Up to now the depression has most been felt on the second-hand market. Numerous shops have gone out of business and sold their equipment, which is now a great load on the market. One large firm of second-hand dealers has no less than 4,000 tools on stock. It can safely be estimated that over 20,000 still serviceable machine tools accumulated by sales of government and private equipment are at present in the hands of the second-hand trade. Prices quoted for second-hand machinery have lately gone down considerably to from 5 to 8 Marks per kilogram, according to condition. Second-hand lathes have lately even been offered at an average price of 3 Marks per kilogram.

The market for heavy machine tools is greatly depressed. It is noteworthy to remember that the Maschinenfabrik Oberschoeneweide, formerly German Niles Works which has been closely connected with Ludwig Loewe A. G., has been shut down and the equipment sold with the exception of the pneumatic tool department; the latter department will be continued in other premises. The stock has changed hands, and the firm has resumed the old style of "Deutsche Niles Werke" or German Niles Works. This is the first instance of a return of styles which have been abandoned during the war owing to apparently foreign associations, and indicates that such styles are no more considered a handicap to business. Close observers may even think that the pendulum will strongly swing in the other direction, as quite a number of purely German firms are now assuming foreign styles in the expectation, apparently, to make a better show on the foreign market.

Imports of Machine Tools

There is little heard of imports of foreign machine tools, specially American, into Germany, although a number of sales have been concluded, among them being several Gleason gear-shaping machines. As regards import-licenses the principle has been established to grant licenses only for tools of a type or quality not made in Germany.

On the strength of this principle the National Cash Register Co., which is equipping large shops near Berlin for the manufacture of its cash registers, has been able to import a large amount of machine tools and small tools from the U. S. The license has aroused strong objections, not from the machine-tool and toolmakers, but from the German rivals of the National Cash Register Co., which now include Krupp's, who have taken up the manufacturing of cash registers, and will soon market that product.

Bankers and Manufacturers Form Foreign-Trade Financing Corporation

A financial undertaking, to which all manufacturers and machine-tool builders will look forward with hopeful interest, was brought about in Chicago early in December. It will possibly afford some relief for the present stagnation of business if the plan is successfully consummated for the formation of a gigantic export financing combine, to be capitalized at $100,000,000, with the possibility of its ultimate extension to a total capitalization of one billion dollars.

At the series of conferences at the Congress Hotel on December 10 and 11 more than 500 of the leading bankers, business men and manufacturers from all over the country were in attendance. The convention was originally planned by the American Bankers Association, as the result of suggestions presented at their annual convention, and its arrangement was handled by a committee under the chairmanship of John McHugh, vice-president of the Mechanics and Metals National Bank of New York.

The new export financing corporation is planned to act under the authorization of the so-called Edge Act recently passed by Congress to take care of such a condition in foreign trade channels as now exists.

At the organization of the meeting Willis H. Booth, vice-president of the Guaranty Trust Co., New York, was elected as permanent chairman, with G. A. Ranney, secretary of the International Harvester Co. to serve as vice-chairman, and William F. Collins of New York, secretary.

Need for the Organization

The scope of the proposed organization was outlined in the opening address by John S. Drum, president of the American Bankers Association. He called attention to the necessity for the creation of some financial machinery to take care of the demands from foreign countries for raw and finished materials, in order that we may get these moving toward their shores as the logical point of consumption. In moving these products we are simply disposing of our excess production. However, in order to promote future world prosperity consideration must be shown alike to both producer and consumer.

Demands have recently been made upon the government to undertake the financing of foreign trade in order to bolster up the condition of falling commodity markets, and these demands were answered in the address by Senator Walter E. Edge, of New Jersey, author of the Edge Act. He stated that when the government attempts to make money it usually loses, as witnessed by the governmental administration of the railroads. He asserted his unalterable opposition to the government administering business in any form, and for this reason thought it better for business to attempt to help itself rather than that the government should intervene and make a mess of it. The problem is so important that it is just as necessary to raise money for this purpose as it was to sell Liberty Bonds during the war. Money must be raised by subscriptions of the business men and the public, as the government could only do so by further burdening the taxpayers.

World Trade Relations

In reporting for the organization committee John McHugh dealt rather fully with the conditions of world trade relations that have brought about the impasse in which our present foreign trade rests. He stated in part: "Prior to the outbreak of the war, in 1914, we were a debtor to the rest of the world to the extent of approximately four billions of dollars. Out of the earnings of our railroads, mills and factories we sent abroad each year upward of two hundred millions of dollars in settlement of interest and in payment of dividends. We practicaly depended upon London to finance such foreign trade as we then had. . . .

"Europe was the center of the world-finance when the war broke out in 1914. Then the state of affairs changed dramatically. . . . When we entered the war in April, 1917, we had already practically wiped out our debt abroad. . . . It is estimated that the floating debt of foreign countries to ourselves has now reached almost $4,000,000,000. The creation of this great debt has enabled our foreign trade to go on. It has brought our total loans to foreigners to $15,000,000,000 and enabled us to pass Great Britain as the leading creditor nation of the world.

"But in extending short-term credits to finance exports during 1919 and 1920 we, as a people, did not stop to consider the total effect on our business and financial structure. These credits were called "short-term" but really were not. They could be shifted about within the country, but so long as our exports exceeded our imports, and so long as people abroad could not meet their obligations with goods, gold or investment loans they could not be paid off. Thus it is seen that $4,000,000,000 of floating credit, extended to facilitate our export trade, has been one of the leading factors in bringing about the credit stringency in the United States, and that stringency, in turn, has been one large factor contributing to the recent violent decline in commodity prices.

"No one will maintain that it has ever been a proper function of commercial banks to finance a relatively permanent one-sided balance of trade, and unless a remedy is found, our export trade must be severely curtailed.

"Conditions are now changed. Our extraordinary prosperity has stopped. Factories and mills have shortened their hours of work; many even have closed down. As for prices, these have fallen sharply; in the last half year wholesale prices on the average have dropped 25 per cent. . . . Goods prepared for export have backed up at all our seaports, owing to ineffectual means to finance their shipments, and our markets are glutted in consequence.

"The success of the plan that is proposed is based upon these two essentials; upon thrift, in order that a part of the savings of our people may be used to finance our foreign trade and thus sustain our prosperity; and production, in order that we may spare the means of supplying foreign markets without subjecting ourselves to increased prices for our own needs.

"We should emphasize that the affairs of the corporation must be so managed that it will be, not only an emergency measure but a permanent instrumentality for the purposes for which it is brought into being.

"We should here adopt articles of incorporation and by-laws, and we should name, if possible, at least some of the men into whose hands we are willing to entrust the destinies of the corporation.

A Mutual Directorship

"We should here name a tentative Board of Directors, and in selecting its members we should be guided by the wishes and opinion of the different groups of bankers, business men and producers representing different parts of the country in this meeting.

"Every stockholder, so far as practicable, should become an agency for distributing the debentures of the corporation. These debentures should be absorbed by the public—not by means of excessive borrowing but by saving.

"There are many instances where American business men have actually ceased to carry on business with foreign customers because of disturbed exchanges; they cannot convert their accumulated foreign funds into American dollars without suffering a loss.

LD'S INDUSTRIAL FORGE
News Editor

"We are presented with the opportunity to finance our trade with the outside world on a stable and permanent basis, through the instrumentality of this great corporation which we have in view. By means of this corporation we could provide for the most careful and thorough credit investigation and the strongest commercial safeguards in the interest of American capital. By means of the corporation we could supply the materials to keep factories and mills running, in the interest of foreign customers. Our loans would be protected, and we would lend in each individual instance only as we felt assured of the security of each particular loan.

"Only as we face the situation that is before us boldly will we seize our present opportunity to maintain our foreign trade, preserve our prosperity, and mitigate our present depression. Only so can we take our full part in meeting our present responsibilities to the world."

Committees were appointed on "Resolutions" and on "Plan and Scope," which reported at the resumption of the conference the following morning. The first committee reported approving the formation of a corporation for the formerly estimated capitalization of $100,000,000; the corporation to be strictly limited to trading with countries which possess a stable form of government; and all transactions to be confined to those which will benefit future trade relations. Co-operation for the formation of the corporation was asked from agriculture, labor, finance and manufacturing industries.

PERSONNEL OF COMMITTEE

The committee on Plan and Scope reported the plan was too big to be handled by a temporary committee and the convention adopted its report favoring the appointment of a permanent committee of thirty. A few well-known men among the personnel of the permanent committee are Chairman John McHugh, of New York; John S. Drunn, San Francisco; James B. Forgan, Chicago; Paul Waller, New York; Philip Stockton, Boston; Paul M. Warburg, New York; and Herbert Hoover.

The committee will be invested with full authority to add to its numbers and "to take all steps decreed by it necessary or appropriate to organize and bring into operation a corporation under the provisions of the Edge Act, with a capital of $100,000,000 for financing future American foreign trade."

The latter principle relative to future foreign trade emanated from the agriculture interests whose purpose it was to prevent the unloading of some of the present floating debt of Europe to America upon the new company. In other words new foreign business, instead of liquidation of old credits piled up in sea board banks, is what the new corporation is established for.

For underwriting the organization expenses of the new corporation it was estimated that the sum of $110,000 will be required and that amount was raised by subscription within a few minutes before the close of the convention.

World's Industrial Exhibition at London in 1922

Announcement is made of a world's industrial exhibition to be held at the Chrystal Palace, London, during the months of May-October, 1922, of the industries, products, arts, sciences, and inventions of the leading manufacturing countries of the world. It will be on a co-operative basis, the capital being provided by the exhibitors and those otherwise connected with the exhibition (such as the guarantors of each nation who guarantee sufficient for the preliminary work connected with the exhibition of their nation), and the profits accruing from the various sources of revenue, such as contracts for advertising, catering, amusements, season tickets, gate receipts, etc., will be apportioned pro rata among the exhibitors in order to bring the cost of exhibiting to the lowest possible figure. Each country will elect its own exhibition committee, which in turn will be represented on the general exhibition committee.

The management will be under the control of a committee representing the exhibitors and guarantors generally.

Tractor Production in the United States

In an investigation made by the Bureau of Public Roads, United States Department of Agriculture, of the production of tractors in the United States during 1919, reports from eighty manufacturers show that they manufactured a total of 164,590 tractors during the year. The number actually manufactured during the year was only a little over one-half of the total production estimated in reports made to the Office of Farm Equipment Control, United States Department of Agriculture, in January and February, 1919. Labor troubles and shortage of material, together with the fact that some of the companies discontinued the building of tractors, accounts in part at least for the decrease in production below the estimated output.

Long Range Machine Gun Developed by Ordnance Department

A new long-range machine gun whose caliber is about one-half inch has recently been successfully tested at the Aberdeen Proving Ground. The development of a gun of this type has been under way in the Ordnance Department for some time, and quite remarkable progress has been made during recent months.

In connection with the development of this weapon the Ordnance Department naturally solicited the aid of John M. Browning, the inventor of the caliber 0.30 Browning machine gun and the Browning automatic rifle of the same caliber, which weapons have been received with remarkable favor by the service; also the aid of the Colt's Patent Fire Arms Manufacturing Co. which was responsible in a large degree for the successful development of the manufacture during the war of the Browning weapons.

The unusual possibilities of the Browning type of mechanism have been clearly demonstrated in the results recently obtained with the new large caliber machine gun. Each round of ammunition fired by this new weapon weighs approximately one-fourth of a pound, and the bullet weighs nearly five and one-fourth times as much as the bullet fired by the Springfield rifle.

The first gun developed and manufactured in accordance with the recent ideas of Mr. Browning and the specifications from the Small Arms Division, Ordnance Office, was tested on Nov. 24, 1920, and those witnessing the test were enthusiastic over the showing which was made. It was demonstrated that the effective range is at least twice as great as the effective range of the caliber 0.30 machine gun. The weight of the gun is about twice as great as that of the caliber 0.30 Browning machine gun. Its water jacket has a capacity of two gallons, and the water used for cooling purposes reaches the boiling point after three hundred rounds of continuous firing.

The rate of firing this weapon can be regulated between 400 and 700 shots per minute by a very ingenious buffer mechanism. Preliminary tests so far conducted indicate that the gun is extremely accurate at long ranges and the grouping of shots unusually good. Accurate fire is easily directed by virtue of the fact that the fixed sight which has been placed upon the top plate of the gun has been placed as near as practicable to the gunner's eye, and on account of the size of the weapon it has been possible to make the sight radius unusually long.

The tripod, as at present tentatively designed for this weapon, weighs about ten pounds more than the gun with the water jacket filled with water. It is believed that the design of this tripod is unusually good, and the firing conducted so far shows it to be very stable.

Several new and desirable features have been added to this unusual weapon which are not found in the caliber 0.30 Browning machine gun, and an attempt has been made in the new weapon to overcome such defects as have developed in the 0.30 caliber type. The gun has a double grip somewhat similar to, but much simpler than, the double grip found on the Maxim and Vickers machine guns, and the excessive racking effect that would inevitably follow from the use of so powerful a weapon as this has been minimized by the use of an ingenious buffer mechanism, which has been added to absorb the recoil. This feature has made possible a considerable reduction in the weight of the weapon.

American Takes Over Canadian Machine Co.

Word comes from Toronto that an agreement has been signed whereby the American Ironing Machine Co., of Chicago, acquires the plant of the Woodstock Worsted Knitting Co., taking a year's lease and option to buy at the end of twelve months. The American Ironing Machine Co. was established in 1905 at Algonquin, about fifty miles from Chicago. The desirability of securing Canadian and other British Empire business led to the decision to establish in the Dominion.

It is planned to commence installing machinery in March next and to start production soon afterward.

Advance Convention Announcement

A triple convention of the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers Association will be held in Atlantic City, New Jersey, May 16, 17, 18, 1921, with headquarters for all three Associations at the Marlborough-Blenheim. F. D. Mitchell, 4106 Woolworth Building, New York, is secretary of the last named association.

At a conference held last week in Atlanta, Georgia, with the executive committee of the Southern Supply and Machinery Dealers' Association, although a preference had been expressed by them that the convention be held in a Southern city, yet because of the many weighty problems which will be presented to the 1921 Convention, they agreed to accept the invitation of the National Supply and Machinery Dealers' Association to meet the Manufacturers in convention at Atlantic City.

Each member is earnestly requested to do his part, not only by sending one or more executives to the convention, but in bringing into the association before the convention one new member.

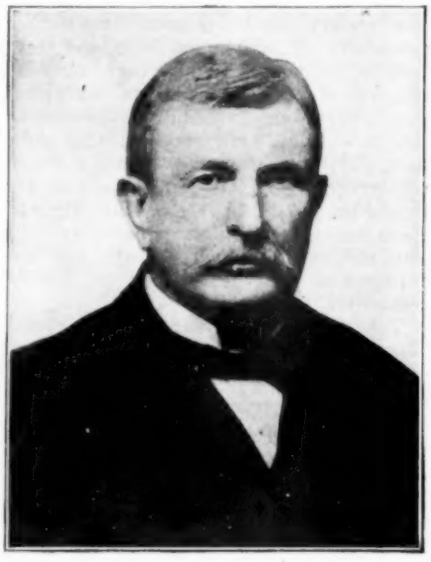
Exports of Manufactures Continue to Increase

Manufactures continue to increase the proportion which they form in our export trade. They actually formed over 51 per cent of our total domestic exports in the ten months ending with October, 1920, against 45 per cent in the calendar year 1919, 47 per cent in the fiscal year preceding the war, 45 per cent in 1910, and 35 per cent in 1900. In fact, says a statement by The National City Bank of New York, manufactures exported in the ten months ending with October, 1920, were 18 per cent greater in value than in the same months of 1919, while the remainder of the domestic merchandise exported shows an actual decrease in the same period. In the ten months ending with October manufactures exported showed an increase of $530,000,000 over the same period of last year, while all other domestic merchandise exported showed an actual decline of $175,000,000.

Obituary

Benjamin Holt

Benjamin Holt, president of the Holt Manufacturing Co. and inventor of the caterpillar tractor, whose inventive mind developed the tanks that took



BENJAMIN HOLT

such a great part in the World War, died in St. Joseph's Hospital, Stockton, Cal., on Dec. 5.

He had been confined to his bed about ten days, and his death came so suddenly there was not sufficient time to summon his family.

Benjamin Holt, by his inventive genius and wonderful ability, gave Stockton its greatest industry, made employment for thousands of men, put agriculture on a higher plane and gave the world a machine that has been characterized as the greatest contribution to the success of the Allies in the great war.

He was born in Merrimac County, New Hampshire on Jan. 1, 1849. His primary education was gleaned in the public schools around his boyhood home, and in an academy at Tilton, N. H. Later he attended a Baptist institution at New London, Conn.

Unlike many inventors and organizers, Holt lived to see the fruition of his dreams and ambitions in the building of two immense factories for the manufacture of his product, to see thousands of those machines sent out to every part of the civilized world, and finally, to realize the greatest triumph of all—the success of the Allied armies, due more than anything else, to the tank and tractors that were the development of his brain.

GEORGE M. WHITIN, treasurer of the Whitin Machine Works, at Whitinsville, Mass., and for thirty-four years the business head of the concern, died at his home in Whitinsville on Dec. 8, after a year's illness. Mr. Whitin was sixty-four years old and was interested in various other industries throughout Massachusetts.

FREDERIC IVER JOHNSON, oldest son of Iver Johnson, inventor and the founder of the arms and cycle works which bears his name, at Fitchburg, Mass., died at his home in Fitchburg, Dec. 9. Mr. Johnson was for a number of years president of the Iver Johnson Arms and Cycle Works, at Fitchburg, but resigned some years ago.

DESMOND H. WHEELER, director and official of the Acme Shear Co., Bridgeport, Conn., for a number of years, died at his home in Bridgeport on Nov. 29 at the age of seventy-one years. Mr. Wheeler was well known in industrial circles in this section.

JOHN B. ADT, president of the John B. Adt Co., Baltimore, Md., manufacturer of machinery, died on Dec. 14 at the home of his son, Edwin B. Adt, in Baltimore. He was 85 years old.

Business Items

The North & Judd Manufacturing Co. of New Britain, Conn., manufacturer of hardware, has increased its capital stock from $2,000,000 to $3,000,000, by adding forty thousand shares at $25 par.

Foster, Merriam & Co. of Meriden, Conn., manufacturer of hardware, has increased its capital stock from $570,000 to $1,000,000.

The Wicaco Screw and Machine Works, Inc., Philadelphia, Pa., announces the removal of its manufacturing plant and general offices to Stenton Ave. and Louden St. The new quarters afford considerably more floor space and more modern equipment.

The Locke Steel Belt Co. of Bridgeport, Conn., manufacturer of steel belts and chain, announces the placing of in-

Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Rust Remover, "Meno"

Peter A. Frasse & Co., Inc., 417 Canal St., New York, N. Y.

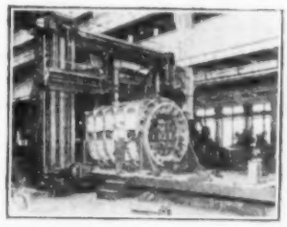
"American Machinist," Nov. 4, 1920

Rusty articles can either be painted with this compound or suspended in a tank containing the compound diluted with water. It is claimed that it will loosen and dissolve rust, grease, oil, dirt, carbon, paint or any other foreign substance irrespective of its age or hardness and that the metal surface will not only not be injured in any way but will be protected from corrosion for a long time after the application. It is also claimed that the compound is safe to use as it will neither burn nor explode.

Planer, 16 Ft.

William Sellers & Co., Inc., 1600 Hamilton St., Philadelphia, Pa.

"American Machinist," Nov. 25, 1920

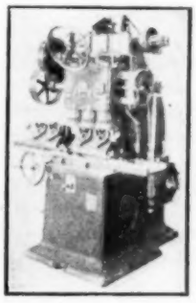


The bed is made in three sections, a central one to which the uprights are bolted and which carries the driving shaft and pinion, and two end sections. The table is driven by the Sellers type drive, through a spiral pinion engaging a rack on the under side of the table. The spiral pinion is mounted on a shaft which is set at an angle of 33 deg. from the center line of the bed, and is about 24 in. long. Specifications: Will plane 16 ft. in width, 13 ft. in height and 36 ft. in length. Width of table, 13 ft. Uprights: width of face, 24 in.; depth, front to back, 10 ft. Cross-rail: face, 27½ in.; height, including reinforcing beam, 51 in. Table rack: pitch, 3¼ in.; face, 12 in. Weight, 412,300 pounds.

Profiling and Milling Machine, Automatic, Multiple-Spindle, "Coulter"

Automatic Machine Co., Bridgeport, Conn.

"American Machinist," Nov. 25, 1920

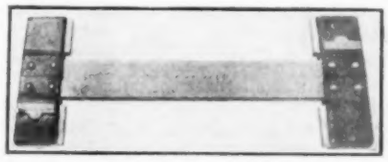


This machine is a modification of that described in the *American Machinist*, page 1332, Vol. 52. It has been equipped with a transfer table designed to permit the use of double or reciprocating fixtures so that a milling operation may be carried on with practical continuity by having one portion of the fixture in position for unloading and reloading while the cutters are at work upon pieces held in the other portion. This machine is adaptable to a wide range of work by reason of the adjustability of the spindle positions and the varied arrangements of the cams possible.

Gages, Snap, Solid and Adjustable

Sheffield Machine and Tool Co., Dayton, Ohio.

"American Machinist," Nov. 25, 1920



The solid, two-sided go and not-go length snap gage is shown. The end-blocks, including anvils and anvil holders, are made up as units and are then assembled to strip-steel beams thus making it possible to secure any desired length. A cylindrical snap gage made by this company is assembled from unit end-blocks and castings in a series of sizes from ¼ in. upward. Anvils are either adjustable or renewable, and both external and internal gages can be furnished.

Press, Punch, Multiple, Double-Crank, Twin-Gear Drive

Toledo Machine and Tool Co., Toledo, Ohio.

"American Machinist," Nov. 25, 1920

As shown, this press is fitted with sixty independently adjustable punches and dies for punching holes with varying distances between the centers. The punch holders are fitted with gags, so that by pulling out or pushing in the gags, holes may be punched or omitted as desired. The press is capable of punching fifteen 1-in. holes through 1⅛-in. steel, and is driven by a 30-hp. motor. Weight, about 165,000 lb. Width between uprights, 103 in. Area of bed, 36 x 102 in. Opening in bed, 4 x 98 in. Area of slide, 22 x 94 in. Diameter of crankpin, 13¾ in. Distance from bed to slide, raised, 33 in.

Welding Machine, Electric-Arc, Portable for Small Work

Electric Arc Cutting and Welding Co., 152-58 Jelliff Ave., Newark, N. J.

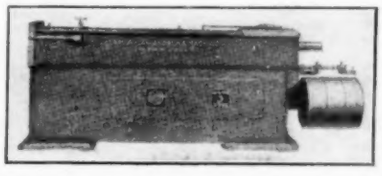
"American Machinist," Nov. 25, 1920

This device weighs 100 lb. and is intended for light work, such as in a garage machine shop. It can use electrodes from $\frac{1}{16}$ to $\frac{5}{32}$ in. in diameter. When using the smaller sizes of electrodes it can be operated continuously, but with the larger sizes the operation must be intermittent. It is possible to operate the machine fom a lamp socket on light loads, but it is intended that the supply wires of the device be attached to the panel board feeding the lights, provided that a current of 5 kva. is available. The machine will operate on any voltage between 90 and 130 and between 180 and 260.

Broaching Machine, Rack-Type, Nos. 1½ and 3

American Broach and Machine Co., Ann Arbor, Mich.

"American Machinist," Nov. 25, 1920

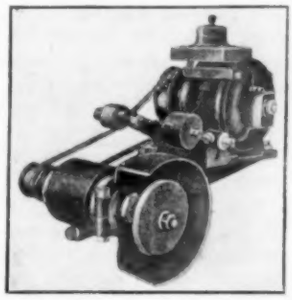


The No. 3 machine is illustrated; it handles broaches 53 in. long, and the No. 1½, up to 40 in. The drive is by belt, the speed reduction being made by means of an inclosed steel worm and phosphor-bronze worm-gear on the rear of the machine. A hardened pinion on the shaft of the worm-gear drives the rack, to which the broaches are attached by means of the sliding head. The section of the rack is D-shaped, the flat side with the teeth being on the bottom. The reversal of motion of the rack is accomplished by shifting the belt at the ends of the stroke. Specifications: Maximum capacity; length of broach, 58 in.; will square or spline hole, 3½ in.; will cut keyways, 1¾ in. Height to center of bore, 32⅜ in. Face, 15 x 14⅜ in. Bore, 5-in. diameter. Weight, crated with countershaft, 4,300 pounds.

Attachment, Grinding, for Lathe

François Chappuis, Room 2632, 120 Broadway, New York, N. Y.

"American Machinist," Nov. 25, 1920



This machine is intended for internal and external cylindrical grinding. Either motor drive, as shown, or countershaft drive can be used; the former is preferable, owing to its ability to operate in any positon desired. The spindle runs in three sets of ball bearings, mounted in an eccentric case, so that the height of the spindle can be regulated. Since the speed of the machine is from 12,000 to 18,000 revolutions per minute, a belt-tightening device is used. A small pulley and a splinter guard are furnished with the machine.

surance on all its employees, numbering about 125. The form is group life insurance, placed with the Travelers Insurance Company of Hartford, Conn.

The Geometric Tool Co. of New Haven, Conn., manufacturer of screw cutting tools, etc., has increased its capital stock from $100,000 to $1,000,000.

The Hubbard Machine Co., ball-bearing manufacturer, 54-70 Commercial St., Worcester, Mass., will remove its plant from there to Hartford, Conn., on Jan. 1, and occupy the new factory recently constructed at the plant of the S. K. F. Ball Bearing Co. on New Park Ave., of which concern the Hubbard Co. is a subsidiary. The new building is a one-sto y brick and steel structure, 75 x 225 ft.

The American Machinery and Equipment Co. of Newington, a suburb of Hartford, Conn., has recently been incorporated to deal in and manufacture machinery, tractors, etc. The capital stock of the company is $500,000.

The Brien Heater Co. of Westfield, Mass., has been taken over by the Phillips & Clark Co. of Geneva, N. Y., and will be removed to that city the first of the year.

The Black & Decker Manufacturing Co., Towson Heights, Baltimore, Md., has established a new branch office at 303 Penn Ave., Pittsburgh, Pa. This office will be the headquarters for the sales force in western New York, western Pennsylvania and northwestern part of West Virginia. It will be in charge of W. D. Royer, formerly sales engineer of the Robbins Electric Co. of Pittsburgh. A service station has also been established at the same address.

Personals

The friends of ALBERT A. BOWMAN, formerly of 2 Charter Oak Ave., Hartford, Conn., are anxious to get in immediate touch with him.

BERTRAM D. TAITT has been selected as superintendent of the National Works of the Wickwire-Spencer Steel Corporation at Worcester, Mass., to succeed James E. McKenny, recently resigned. Mr. Taitt has been assistant superintendent of the same plant for the past two years previous to which he was general manager of the Stenman Wire Specialty Co. of Worcester.

JOHN H. GOSS, general superintendent of the Scovill Manufacturing Co. of Waterbury, Conn., was elected first vice president of the Connecticut Chamber of Commerce, at the annual meeting held in Hartford recently.

STANLEY H. BULLARD, vice president of the Bullard Machine Tool Co. of Bridgeport, Conn., manufacturer of machinery, was elected president of the Connecticut Chamber of Commerce at the annual meeting of the chamber held in Hartford on Dec. 8. Mr. Bullard succeeds Charles E. Chase.

FRANK O. HOWARD, who has been connected with the North Works of the American Steel and Wire Co. at Worcester, Mass., for the past eleven years has been appointed manager of the new office the company has opened in Atlanta, Ga. Mr. Howard has already started in with his new duties.

C. F. LEWIS, metallurgist of the Greenfield Tap and Die Corporation of Greenfield, Mass., resigned his position on Dec. 1 to take charge of the metallurgical department of the American Tube and Stamping Co.'s plants at Bridgeport, Conn.

LAWRENCE M. KEELER, agent and also a director of the Whitin Machine Works at Whitinsville, Mass., is planning a trip to Japan and China in February in connection with business interests of the company.

HENRY REEVES, for years with the Stocker-Rumely Co. and since the reorganization with the Stocker-Rumely-Wacks Co., will be auditor and credit manager of the Dale-Brewster Co., starting on Jan. 1.

ROBERT F. KIMBER, formerly of the Le Moyne Steel Co., will have charge of sales in the milling cutter and special tool department of the Cooney-Dunn Co., New York and Mt. Vernon, N. Y.

BERKELEY WILLIAMS, until recently chief engineer of the F. H. Lawson Co., Cincinnati, Ohio, is now general manager of the Chatham Manufacturing Co., Middletown, Conn.

W. L. CHURCHILL and ALBERT MCDONALD announce the formation of the McDonald-Churchill Corporation, industrial engineering service, New York City. Mr. Churchill, president, was formerly engaged in consulting industrial engineering, and Mr. McDonald, vice-president and general manager, was formerly vice-president of the C. E. Knoeppel & Co., Inc., New York.

F. J. MORSCHES and ALBERT DUDLEY have been appointed assistant superintendents at the Black Diamond File Works of the G. & H. Barnett Co., Philadelphia, Pa. Mr. Morsches was for a number of years connected with the Nicholson plant at Anderson, Indiana; Mr. Dudley was formerly chief machinist at the Philadelphia plant of the same company.

Trade Catalogs

Duff Lifting Jacks. The Duff Manufacturing Co., Pittsburgh, Pa. Catalog No. 104, pp. 148. This company has issued a catalog describing and illustrating its complete line of Duff lifting jacks. It also includes jacks for all purposes—railway, automotive and industrial, in sizes ranging from 1 to 75 tons lifting capacity.

Dodge Standardized Elevators and Conveyors. Dodge Sales and Engineering Co., Mishawaka, Ind. This catalog contains 160 6 x 9-in. pages and 150 illustrations, and covers the elevator and conveyor field in a thorough and comprehensive manner. Gear design, drives, pitches, teeth, shaft sizes and speed regulation are some of the subjects presented.

Do You Know How to Make a Chisel. Joseph T. Ryerson & Son., Chicago Ill. This company has issued a small three-page leaflet containing a description on how to make a chisel.

Uses and Treatments of high-speed and tool steel. Halcomb Steel Co., Syracuse, N. Y. A 7 x 11-in. chart giving specifications for heat-treating eight brands of steel. Hardening temperatures, and directions for various degrees of hardness are included. The uses of these eight brands of Halcomb steel are also given.

Electric Overhead Cranes and Hoists. Victor R. Browning, 17701 Lake Shore Blvd., Cleveland, Ohio. Catalog, pp. 23, 8½ x 11 in. The views illustrated in this catalog show practical installations of the different types of electric overhead cranes and hoists.

Electric Air Heaters. C-H Convector Type Electric Air Heaters are illustrated and described in a new 4-page 8½ x 11-in. leaflet, being distributed by the Cutler-Hammer Manufacturing Co., of Milwaukee, and New York, and known as Publication 862. The leaflet also tells briefly the advantages of electric heat over other forms of heating and gives thumb rules which enable the customer to closely estimate the number or size of heaters required for any particular installation. The C-H Convector Type Air Heater is described as being a compact and sturdy appliance. It consists of several of the widely-known C-H Space Heaters mounted horizontally between cast-iron end plates and completely enclosed in a protecting screen of perforated sheet metal, so that nothing inflammable can touch the heaters or any live parts. The heaters are made in eight different capacities ranging from 1 to 5 kw. for standard commercial voltages, and all except the smallest and largest sizes are designed for three different heats.

Wave Power Tools. W. H. Dorman & Co., Ltd., Stafford, England. Booklet, pp. 68, 8½ x 11 in. This booklet presents a series of practical working appliances which economically transmit and apply energy by waves through water. It is profusely illustrated.

Chucks and Collets. The Charles L. Jarvis Co., Gildersleeve, Conn. A small folder briefly describing its quick-change chucks and collets.

Regulators. American Galco., Inc., New York City. Catalog, 9 x 11 in. An illustrated and descriptive catalog of its different types of regulators.

Wayne Oil and Gasoline Storage Systems—Oil Filtration Systems—Oil Burning Systems—Furnaces for Metal Melting, Forging and Heating.—Wayne Oil Tank and Pump Co., Fort Wayne, Ind. This 9 x 11-in. catalog is a beautiful example of the printer's art. The cover is printed with raised letters, is imitation leather and incloses a large number of bulletins issued by the company and advertising its products. The cover is made so that new bulletins can be added.

Handbook for Drillers. The Cleveland Twist Drill Co., Cleveland, Ohio. Booklet, pp. 37, 4¾ x 8 in. This volume is designed for students of drilling; it is not a complete treatise on the subject, but gives an introduction to the theory underlying the use of the twist drill. The company charges a nominal sum for this booklet.

The Primary Function of a Vise. Reed Manufacturing Co., Erie, Pa. This small pamphlet describes the functions of a vise.

Forthcoming Meetings

The Society of Automotive Engineers will hold its annual meeting on Jan. 11 to 13 inclusive at New York.

The Engineering Institute of Canada will hold its thirty-fifth annual meeting in Toronto, King Edward Hotel, on Feb. 1, 2 and 3.

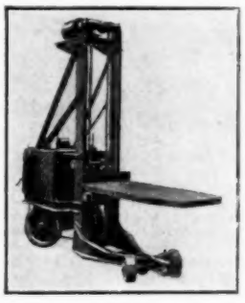
A triple convention of the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association will be held in Atlantic City, N. J., May 16, 17 and 18, 1921, with headquarters for all three associations at the Marlborough-Blenheim. F. D. Mitchell, 4106 Woolworth Building, New York, is secretary of the last-named association.

The Spring Convention of the National Machine-Tool Builders' Association will be held on Thursday and Friday, May 19 and 20, at Hotel Traymore, Atlantic City, N. J. Chas. E Hildreth, care of the Association, Worcester, Mass., is general manager.

Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Truck, Tier-Lift, No. 703-A
Lakewood Engineering Co., Cleveland, Ohio
"American Machinist," Nov. 25, 1920.

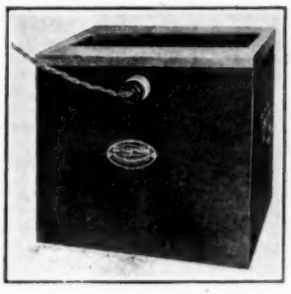


The general characteristics of the machine are similar to those of the Model 703 truck described in the *American Machinist* on page 52, vol. 52. Both models are built in four sizes with lifts of 42, 60, 76 and 96 in., respectively. The difference is that the Model 703-A machine has an elevating speed nearly twice as great as the other machine, its maximum load being 2,000 lb., while that of the 703 truck is 4,000. The new model is intended especially for the handling of rather light, bulky packages.

Torch, Kerosene, Style "T"
Mahr Manufacturing Co., Minneapolis, Minn.
"American Machinist," Nov. 25, 1920.

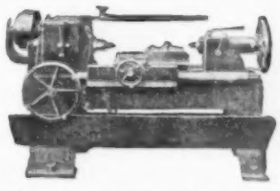
This torch is intended for use in foundries, tin shops, machine shops, or wherever a small heating appliance is required. It is stated that the torch operates under a wide range of pressure, so that a few strokes of the pump will provide sufficient pressure to last for an hour. Starting the torch requires about four minutes. It is made in three sizes, ½, 1 and 1½ gal., the oil consumptions being, respectively, 1, 2 and 3 quarts per hour. The net weights are 6½, 8½ and 10½ lb., the box weights, 12½, 15½ and 18½ lb., and the volumes when boxed are 1, 1.5 and 2 cu.ft.

Demagnetizer, "Demagnetool" No. 2
William Brewster Co., Inc., 30 Church St., New York.
"American Machinist," Nov. 25, 1920.



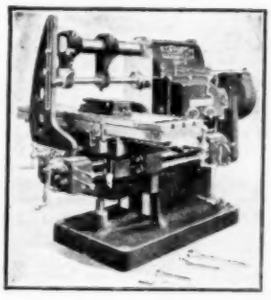
A type of demagnetizer suitable for production work, and with which it is not necessary either to rub or to place the work on the plate of the device is shown. It is only necessary to drop or pour the work through the opening in order to demagnetize it. It is claimed that, due to the design of the transformer, the magnetic flux crosses at right angles the opening through which the work is passed, so that the action extends equally to all points of the working space. The No. 2 has an opening 6 x 12 in., but other sizes can be furnished.

Lathe, Double-Carriage, Production
Hamilton Machine Co., Hamilton, Ohio
"American Machinist," Dec. 2, 1920.



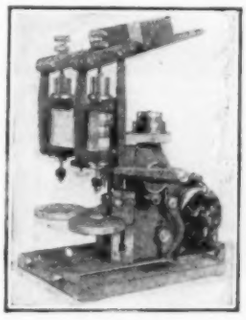
The object of the two carriages is to enable the turning and facing operations to be performed at the same time; the front carriage holds the turning tools, while the rear one carries the facing tools. The machine is intended for production work on such parts as steering knuckles for automobiles and tractors, small shafts, axle parts and gears of different types. It is stated that when the lathe is properly tooled for a given job, it may be run by a comparatively unskilled operator and yet give speedy production and accurate work.

Milling Machine, Plain, "Maximiller No. 2"
Kempsmith Manufacturing Co., Milwaukee, Wis.
"American Machinist," Dec. 2, 1920.



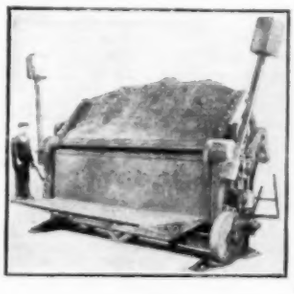
Specifications: Working surface of table, 12 x 56 in. Table adjustment: Longitudinal, 28 in.; transverse, 10 in.; vertical, 19 in. Face of column to brace, 24¾ in. Arbor: diameter, 1¼ in.; length shoulder to nut, 22¼ in. Spindle: front bearing, 4¾ in. diameter by 4⅞ in. long; taper hole, No. 12 B. & S.; hole through spindle, 1¼ in. Driving pulley: 3½ x 15 in.; speed, 400 r.p.m. Spindle speeds: number 18; range, 16 to 400 r.p.m. Feeds: number, 18; range, ⅛ to 25 in. per minute. Power quick traverse: longitudinal, 100 in. per minute; transverse and vertical, 36 in. per minute. Floor space, 85 x 105 in. Weight: net, 4,200 lb.; domestic shipping, 4,500 lb.; export, 4,900 lb.

Drilling Machine, Sensitive, Automatic
Kingsbury Manufacturing Co., Keene, N. H.
"American Machinist," Dec. 2, 1920.



The machine is intended for production drilling on small parts. Specifications: Capacity, ⅝-in. drills. Spindles; diameter, ⅞ in.; standard stroke, ¾ in.; vertical adjustment, ¾ in. Vertical adjustment of tables, 5 in. Distance between spindles, 8 in. Spindle to column, 6 in. Bottom of chucks to tables, maxmium, 8 in. No. of speeds, 3; 1,500, 2,400 and 3,750 r.p.m. with drive-shaft speed of 750 r.p.m. Drive pulley, 5 in. Height, 28 in. Base; belt-drive, 16 x 20 in.; motor drive, 16 x 24 in. Weight; belt drive, 250 lb.; motor drive, 270 lb.

Brake, Plate-Bending
Dries & Krump Manufacturing Co., Chicago, Ill.
"American Machinist," Dec. 2, 1920.

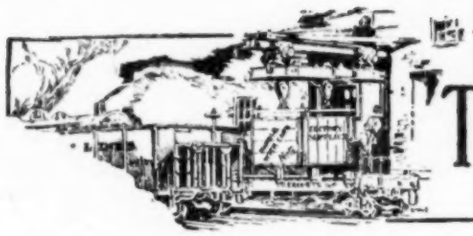


This machine is said to be the largest plate-bending brake in the world. The brake weighs 30 tons, and can bend cold plates 12 ft. long up to ¾ in. thick. It is built of steel throughout. The housings are steel castings, the links which connect the upper and lower jaws being forgings. The nose of the upper jaw carries a tool-steel edge. The motor is mounted within the machine, driving a shaft carrying direct and reverse friction clutches. The reverse motion for lowering the bending leaf is obtained through an idler gear. Floor space required, 16 x 12 ft.

Milling Machine, Continuous, "Model 0-3"
Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
"American Machinist," Dec. 2, 1920.

This machine is intended for face-milling the ends of such work as shafts, rods and crankshafts. A production of 250 pieces per hour can be obtained, the shafting being 1⅝ in. in diameter. The machine consists of a heavy bed carrying two heads, one of them being movable along the bed in order to accommodate work of different lengths. An individual motor drive is employed. End or face mills are used, a depth adjustment being provided. The work is secured at each end in a fixture fastened to the head. The feed motion is obtained by rotation of the fixtures.

Clip, paste on 3 x 5-in. cards and file as desired



THE WEEKLY PRICE GUIDE

IRON AND STEEL

PIG IRON—Quotations compiled by The Matthew Addy Co.:

CINCINNATI	Current	One Year Ago
No. 2 Southern	$44 50	$30.35
Northern Basic	40 00	27.55
Southern Ohio No. 2	42 00	28.55
NEW YORK—TIDEWATER DELIVERY		
2X Virginia (Silicon 2.25 to 2.75)	51.26	32.40
Southern No. 2 (Silicon 2.25 to 2.75)	48.26	35.20
BIRMINGHAM		
No. 2 Foundry	40.50	29.25
PHILADELPHIA		
Eastern Pa., No. 2x, 2.25 2.75 sil.	42 50	29.00-30.00
Virginia No. 2	46 25	33.10
Basic	38 25	26.75
Grey Forge	40 25	26.75
CHICAGO		
No. 2 Foundry local	40 00	26.75
No. 2 Foundry, Southern	46 66	28.00
PITTSBURGH, INCLUDING FREIGHT CHARGE FROM VALLEY		
No. 2 Foundry	41 96	28.15
Basic	38 00	27.15
Bessemer	38 00	29.35

* F.o.b. furnace. † Delivered.

STEEL SHAPES—The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York Current	New York One Month Ago	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Structural shapes	$3 80	$4 15	$3.47	$3.58	$3.37	$3.58	$3.47
Soft steel bars	3 70	4 15	3.37	3.34	3.27	3.48	3.37
Soft steel bar shapes	3.70	4 15	3.37	3.48	3.27	3.48	3.37
Soft steel bands	4.65	5 50	4.07	6.25	....	....	....
Plates, ¼ to 1 in. thick	4 00	4 15	3.67	3.78	3.57	3.78	3.67

BAR IRON—Prices per 100 lb. at the places named are as follows:

	Current	One Year Ago
Mill, Pittsburgh	$4.25	$2.77
Warehouse, New York	4.75	3.37
Warehouse, Cleveland	3.52	3.27
Warehouse, Chicago	4.12	3.37

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

Blue Annealed	Large Mill Lots Pittsburgh	New York Current	New York One Year Ago	Cleveland	Chicago
No. 10	3.55	5.20	4.57	5.00	6.13
No. 12	3.60	5.25	4.62	5.05	6.18
No. 14	3.65	5.30	4.67	5.10	6.23
No. 16	3.75	5.40	4.77	5.20	6.33
Black					
Nos. 18 and 20	4.20	6.30	5.30	5.60	6.90
Nos. 22 and 24	4.25	6.35	5.35	5.75	6.95
No. 26	4.30	6.40	5.40	5.80	7.00
No. 28	4.35	6.50	5.50	5.90	7.10
Galvanized					
No. 10	4.70	7.05	5.75	6.25	7.25
No. 12	4.80	7.15	5.85	6.35	7.30
No. 14	4.80	7.15	5.85	6.35	7.45
Nos. 18 and 20	5.10	7.40	6.15	6.65	7.75
Nos. 22 and 24	5.25	7.55	6.30	6.80	8.15
No. 26	5.40	7.70	6.45	6.95	8.30
No. 28	5.70	8.00	6.75	7.25	8.60

Acute scarcity in sheets, particularly black, galvanized and No. 16 blue enameled. Automobile sheets are unavailable except in fugitive instances, when prices are 9.45c per lb. for No. 16; 9.50 for Nos. 18 and 20, and 9.55c for Nos. 22 and 24.

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting or screw stock, per 100 lb. base	$5 50	$5.80	$4 84
Flats, square and hexagons, per 100 lb. base	6.00	6.30	5.34

DRILL ROD—Discounts from list price are as follows at the places named:

	Per Cent.
New York	50
Cleveland	50
Chicago	50

NICKEL AND MONEL METAL — Base prices in cents per pound F. O. B. Bayonne, N. J.

Nickel	
Ingot and shot	43
Electrolytic	45

Monel Metal			
Shot and blocks	35	Hot rolled rods (base)	42
Ingots	38	Cold rolled rods (base)	56
Sheet bars	40	Hot rolled sheets (base)	55

Special Nickel and Alloys	
Malleable nickel ingots	45
Malleable nickel sheet bars	47
Hot rolled rods, Grades "A" and "C" (base)	60
Cold drawn rods, grades "A" and "C" (base)	72
Copper nickel ingots	42
Hot rolled copper nickel rods (base)	52
Manganese nickel hot rolled (base) rods "D" — low manganese	64
Manganese nickel hot rolled (base) rods "D"— high manganese	67

Domestic Welding Material (Swedish Analysis)—Welding wire in 100-lb lots sells as follows, f. o. b. New York: 5/32, 8½c. per lb.; ¼, 8c.; 5/16 to ½, 7¼c Domestic iron sells at 12c. per lb.

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York Current	Cleveland Current	Chicago Current
Openhearth spring steel (heavy)	7.00	8.00	9.00
Spring steel (light)	10.00	7.00	12.00
Coppered bessemer rods	9.00	8.00	6.75
Hoop steel	4.70	4.04	5.32
Cold-rolled strip steel	9.50	8.25	10.75
Floor plates	6.25	4.00	6.63

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card:

BUTT WELD

Steel Inches	Steel Black	Steel Galvanized	Iron Inches	Iron Black	Iron Galvanized
⅛ to 3	54–57½%	41½–44%	⅛	15½–25½%	+1½–11%
			¼	19½–29½%	1½–11½%
			⅜ to 1¼	24½–34½%	8 –18½%

LAP WELD

2	47 –50½%	34½–38%	1¼	....	....
2½ to 6	50 –53½%	37½–41%	1½	....	....
7 to 12	47 –50½%	33½–37%	2	20½–28½%	6½–14½%
13 to 14	37½–41 %	....	2½ to 6	22½–30½%	9½–17½%
15	35 –38½%	....	7 to 12	19½–27½%	6½–14½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛ to 1¼	52 –55½%	39½–43%	⅛ to 1¼	24½–34½%	9½–19½%
2 to 3	53 –56½%	40½–44%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	45 –48½%	33½–37%	1¼	....	....
2½ to 4	48 –51½%	36½–40%	1½	....	....
4½ to 6	47 –50½%	35½–39%	2	21½–29½%	8½–16½%
7 to 8	43 –46½%	29½–33%	2½ to 4	23½–31½%	11½–19½%
9 to 12	38 –41½%	24½–28%	4½ to 6	22½–30½%	10½–18½%
			7 to 8	14½–22½%	2½–10½%
			9 to 12	9½–17½%	5½–+2½%

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv	Chicago Black	Chicago Galv.
⅛ to 3 in. steel butt welded	38%	22%	39%	30%	54%@40%	40½@30 %
2½ to 6 in. steel lap welded	33%	18%	41%	26%	50@40%	37½@27½%

Malleable fittings. Classes B and C, banded, from New York stock sell at plus 45%. Cast iron, standard sizes, plus 5%.

METALS

MISCELLANEOUS METALS—Present and past New York jobbers' quotations in cents per pound, in quantities up to car lots:

	Current	Month Ago	Year Ago
Copper, electrolytic	15.00	15.50	22.50
Tin in 5-ton lots	35 25	38 75	56.50
Lead	5 75	6 75	6.25
Zinc	7.00	7 00	7.60
ST. LOUIS			
Lead	6.25	7.25	6.00
Zinc	6.75	6.25	7.15

At the places named, the following prices in cents per pound prevail, for 1 ton or more:

	New York Current	New York Month Ago	New York Year Ago	Cleveland Current	Cleveland Year Ago	Chicago Current	Chicago Year Ago
Copper sheets, base	22.50	23.50	33.50	24.50	35.50	28.50	36.50
Copper wire (carload lots)	17.00	20.00	30.75	22 00	30.50	25 00	26.00
Brass sheets	20.25	28.50	32.00	25 00	33.00	25 25	28.00
Brass pipe	25.00	28.00	36.00	27.00	39.00	30 00	37.00
Solder (half and half) (case lots)	27.75	29.00	45.00	29.00	41.00	22.50	38.50

Copper sheets quoted above hot rolled 24 oz., cold rolled 14 oz. and heavier, add 2c.; polished takes 5c. per sq.ft. extra for 20-in. widths and under; over 20 in., 7½c.

BRASS RODS—The following quotations are for large lots, mill. 1000 lb. and over, warehouse; net extra:

	Current	One Year Ago
Mill	18.25	24.00
New York	18 25	28.00@29.75
Cleveland	23 00	29.00
Chicago	23 25	27.00

SHOP MATERIALS AND SUPPLIES

ZINC SHEETS—The following prices in cents per pound are f.o.b. mill + less 8% for carload lots 11.50

	Warehouse			
	—In Casks—		— Broken Lots —	
	Current	One Year Ago	Current	One Year Ago
Cleveland	15.30	12.50	14.70	13.00
New York	14.00	11.50	14.50	12.50
Chicago	14.50	16.50	14.95	16.00

ANTIMONY—Chinese and Japanese brands in cents per pound, in ton lots for spot delivery, duty paid:

	Current	One Year Ago
New York	6.25	9.50
Chicago	7.00	9.75
Cleveland	7.50	9.75

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	—*New York—			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy, and crucible	12.00	17.00	10.00	11.50
Copper, heavy, and wire	11.50	16.00	9.50	11.00
Copper, light, and bottoms	10.00	14.00	9.00	9.50
Lead, heavy	4.00	4.75	4.00	4.50
Lead, tea	3.00	3.75	3.00	3.50
Brass, heavy	7.00	10.50	7.00	10.50
Brass, light	5.50	7.50	5.00	5.50
No. 1 yellow brass turnings	6.50	10.00	5.50	5.50
Zinc	4.50	5.00	3.00	4.50

*These prices nominal because of dull market

ALUMINUM—The following prices are from warehouse at places named:

	New York	Cleveland	Chicago
No. 1 aluminum, 98 to 99% pure, in ingots for remelting (1-15 ton lots), per lb	$33.00	$26.00	$33.50

COPPER BARS—From warehouse sell as follows in cents per pound, for ton lots and over:

	Current	One Year Ago
New York (round)	28.00	32.00
Chicago	21.00	31.00
Cleveland	25.00	35.00

BABBITT METAL—Warehouse price per pound:

	—New York—		—Cleveland—		— Chicago —	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	70.00	90.00	76.00	70.00	43.00	60.00
Commercial	30.00	50.00	16.50	16.50	11.00	13.00

NOTE—Price of babbitt metal is governed largely by formula, no two manufacturers quoting the same prices. For example, in New York we quote the best two grades, although lower grades may be obtained at from $16 to $20.

SHOP SUPPLIES

NUTS—From warehouse at the places named, on fair-sized orders, the following amount is deducted from list:

	— New York —		— Cleveland —		— Chicago —	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Hot pressed square	+$1.25	$1.50	List net	$2.25	+1.15	1.85
Hot pressed hexagon	+ 1.25	1.50	List net	2.25	+1.15	1.85
Cold punched hexagon	+ 1.25	1.50	List net	2.25	+1.15	1.30
Cold punched square	+ 1.25	1.50	List net	2.25	+1.15	1.30

Semi-finished nuts, ⅜ and smaller, sell at the following discounts from list price:

	Current	One Year Ago
New York	30%	50–10%
Chicago	40%	50%
Cleveland	50%	55%

MACHINE BOLTS—Warehouse discounts in the following cities:

	New York	Cleveland	Chicago
½ by 4 in. and smaller	+ 10%	5%	20%
Larger and longer up to 1¼ in. by 30 in.	Net list	4%	10%

WASHERS—From warehouses at the places named the following amount is deducted from list price:

For wrought-iron washers:
New York..... list Cleveland..... $2.75 Chicago..... $1.90

For cast-iron washers, ⅜ and larger, the base price per 100 lb. is as follows:
New York..... $7.00 Cleveland..... $4.50 Chicago..... $5.50

CARRIAGE BOLTS—From warehouses at the places named the following discounts from list are in effect:

	New York	Cleveland	Chicago
½ by 6 in. and smaller	+ 20%	40%	20%
Larger and longer up to 1 in. by 30 in.	+ 20%	35%	15%

COPPER RIVETS AND BURS sell at the following rate from warehouse:

	Rivets		Burs	
	Current	One Year Ago	Current	One Year Ago
Cleveland	25%	20%	10%	10%
Chicago	net	20%	net	20%
New York	30%	40%	net	20%

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	20%	50%	30%
Tinned	20%	50%	30%

Boiler, ½, ⅝, 1 in. diameter by 2 to 5 in. sell as follows per 100 lb.:
New York..... $6.00 Chicago..... $5.73 Pittsburgh..... $4.60

Structural, same sizes:
New York..... $5.73 Chicago..... $5.83 Pittsburgh..... $4.50

MISCELLANEOUS

SEAMLESS DRAWN TUBING—The base price in cents per pound from warehouse in 100-lb. lots is as follows:

	New York	Cleveland	Chicago
Copper	$26.00	30.00	31.00
Brass	25.00	27.00	30.00

The prices, of course, vary with the quantity purchased. For lots of less than 100 lb., but not less than 75 lb., the advance is 1 c.; for lots of less than 75 lb., but not less than 50 lb., 2½c. over base (100-lb. lots); less than 50 lb., but not less than 25 lb., 5c. should be added to base price; quantities from 10-25 lb., extra is 10c.; less than 10 lb., add .15–20c.

Double above extras will be charged for angles, channels and sheet metal mouldings if ordered in above quantities. Above extras also apply to brass rod other than standard stock sizes—stock sizes being considered as ⅛-2 in. inclusive in rounds, and ⅛-1½ in., inclusive, in square and hexagon—all varying by thirty seconds up to 1 in. by sixteenths over 1 in. On shipments aggregating less than 100 lb., there is usually a boxing charge of $1.50.

LONG TERNE PLATE—In Chicago No. 28 primes from stock sell, nominally, for $8.85 per 100 lbs.

In Cleveland—$10 per 100 lbs.

COTTON WASTE—The following prices are in cents per pound:

	—— New York ——			
	Current	One Year Ago	Cleveland	Chicago
White	13.00@15.00	13.00	15.00	15.00@17.00
Colored mixed	7.00@12.00	9.00–12.00	11.00	11.00@13.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½x13½	13½x20½
Cleveland	55.00	65.00
Chicago	41.00	43.50

SAL SODA sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$2.00	$2.00	$1.75
Philadelphia	2.75	2.75	1.75
Cleveland	3.00	3.00	2.50
Chicago	2.00	2.75	2.00

ROLL SULPHUR in 360-lb. bbl. sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$3.50	$3.90	$3.65
Philadelphia	3.65	3.65	3.87
Chicago	3.85	5.00	4.12½

COKE—The following are prices per net ton at ovens, Connellsville:

	December 20	December 13	December 6
Prompt furnace	$7.00@$7.50	$8.00@$10.50	$8.00@$10.50
Prompt foundry	8.50@ 9.00	10.00@ 12.00	10.00@ 12.00

FIRE CLAY—The following prices prevail:

		Current
Ottawa, bulk in carloads	Per Ton	$8.00
Cleveland	100-lb. bag	1.00

LINSEED OIL—These prices are per gallon:

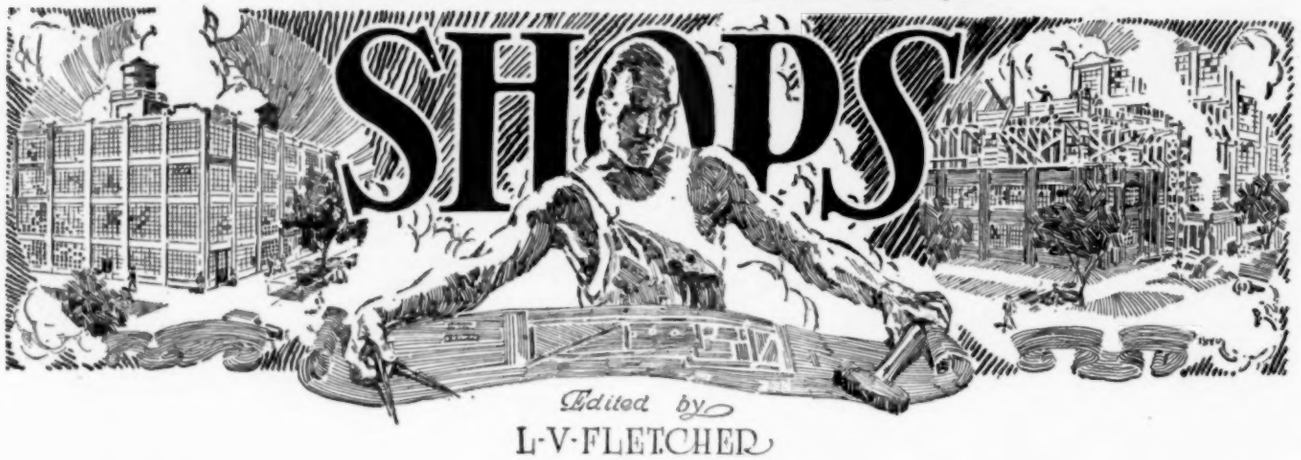
	—New York—		—Cleveland—		—Chicago—	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw in barrels, (5 bbl. lots)	$0.90	$2.15	$1.05	$2.50	$1.01	$2.37
5-gal cans	1.05	2.30	1.30	2.75	1.26	2.57
1-gal cans (6 to case)	1.15	....	....	....	....	....

WHITE AND RED LEAD—Base price per pound:

	— Red —				— White —	
	Current		One Year Ago		Current	One Year Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100 lb. keg	14.00	15.50	13.00	14.50	14.00	13.00
25 and 50-lb. kegs	14.25	15.75	13.25	14.75	14.25	13.25
12½-lb. keg	14.50	16.00	13.50	15.00	14.50	13.50
5-lb. cans	17.00	18.50	15.00	16.50	17.00	15.00
1-lb. cans	19.00	20.50	16.00	17.50	19.00	16.00

500 lb. lots less 10% discount. 2,000 lb. lots less 10-4% discount. 10,000 lb. lots less 10-7½% discount.

NEW and ENLARGED



Edited by
L·V·FLETCHER

Machine Tools Wanted

If in need of machine tools send us a list for publication in this column

Mass., Worcester—J. Johnson, 26 Spofford Rd.—garage equipment.

Vt., Sprinfield — Gilmore & Co. — equipment for the manufacture of lathes.

N. J., Camden—The Dexter Metal Mfg. Co., Front and Arch Sts.—one 18-in. lathe.

N. Y., Patchogue — C. B. Loundes —one lathe with a 26 x 12 ft. bed.

N. Y., Schenectady—The General Electric Co., River Rd.—miscellaneous machine tool equipment.

La., New Orleans—H. M. Jannette, Room 712 Hennen Bldg.—one 12 in x 19 in. Le Blond lathe (new or used).
One 20 in. drill press (Champion or Hoefer).
One steam hammer.
One hazel power hammer (steam or electric).

Va., Richmond — The Auto Car Service Co., Richmond Meadows and Broad St.—large drill press.

Va., Richmond—A. I. Flemmig, 305 North Munford St.—medium size lathe and drill press for welding and repairing work.

Va., Richmond—C. H. Martin & Co., 221 West Broad St., C. H. Martin, Purch. Agt. —electric drill press and small lathe for its repair shop (new or used).

Va., Richmond—The Richmond Auto Repair Service, 509 West Marshall St., J. A. Scrapps, Purch. Agt.—drill press, small lathe and air compressor.

Va., Richmond — Shewbridge & Hare, Richmond Meadows above Broad St.—carbon removing out-fit and electric drill with valve grinding attachments, for auto repair shop.

Va., Richmond—The Southern Auto Repair Co., 210 North Madison St.—small lathe and battery testing and charging outfit.

Va., Richmond — The Younglove Auto Body Wks., 310-312 North Henry St., A. Younglove, Purch. Agt.—band saw, jointer and drill press.

Ill., Chicago—The Amer. Ironing Machine Co., 168 North Michigan Ave.—machinery for its factory at Woodstock, Ont.

Ill., Chicago—The Chicago, Indianapolis & Louisville Ry., (Monon Route), 608 South Dearborn St.—equipment for its car repair shop at Lafayette, Ind.

Mich., Birch Run—W. R. Hadsell—repair equipment for garage.

Mich., Detroit—The Royal Machine Co., 536 East Fort St.—miscellaneous machine shop equipment.

Mich., Detroit—Smiths Garage, 959 14th St., C. Smith, Purch. Agt.—one small lathe for repair work (used).

Mich., Detroit—The Walker Liberty Machine Co., 6913 East Jefferson Ave., Manufacturers of automobile part—one 20 in. disc grinder (used).

Mich., Kalamazoo—The Hill Curtis Co., North Pitcher St., manufacturers of saw mill machinery, N. Gumbinsky, Secy.—one 24 in. or 30 in. pulley lathe, (new or used).

Wis., Amery—The Amery Mfg. Co., P. C. Amundson, Purch. Agt.—machinery for the manufacture of gasoline engines, etc.

Wis., Caledonia — Goebel Bros., J. J. Goebel, Purch. Agt. — garage repair machinery.

Wis., Milwaukee — F. Luenzmann Co., 31st St. and Auer Ave., C. Luenzmann, Purch. Agt.—double head pony planer.

Wis., Milwaukee—The Milwaukee Specialty Mfg. Co., 884 23rd Ave., R. C. Frank, Purch. Agt.—lathe and drill press.

Wis., Milwaukee — The Standard Steel Corp., 1251 30th St., manufacturers of agricultural implements, etc., E. J. DeGuenther, Purch. Agt.—one 20-in. or 24-in. shaper and one 16-in. or 18-in. lathe.

Wis., Milwaukee — C. J. Trispel, 3915 Walnut St., (machinist)—small screw cutting lathe.

Kan., Leavenworth—The Great Western Mfg. Co., 2nd and Choctaw Sts., manufacturers of mill machinery—one brake to handle sheets 10 ft. long, No. 8 gage and lighter.

Ia., Sac City—H. L. Simonds—multiple spindle nut making machine, similar to National.

Ont., Toronto—The Canadian Allis-Chalmers, Ltd., 212 King St., W.—one No. 140 Bliss straight double crank press, geared type not less than 84 in. between housings or similar.

One No. 6 Bliss double crank press, geared type, not less than 84 in. between uprights.

One No. 21 Bliss inclinable press of flywheel or geared type or similar.

Two No. 3½ Bliss Stiles pattern, power punch presses, fly-wheel type or similar.

One No. 6 Bliss double crank press, geared type, 42 in. between uprights or similar.

One set smoothing rolls similar to Bliss No. 118a, length 36 in.

One No. 5 Springfield oscillating die grinder, which will have a grinding capacity of 24 in. to 30 in. wide, 24 in. high, and 5 ft. long, 48 in. to 52 in. between uprights or similar type.

One shear blade grinder to handle blade 60 in. long for squaring shears for cutting ½ in. material.

One power squaring shear of 130 in. length, capacity for cutting material up to ½ in. thick or similar.

One baling machine 1⅛ in sheet scrap.

Machinery Wanted

N. J., Trenton—The Sanitary Ice & Coal Co., Old Rose St.—machinery for cold storage plant.

Ill., Chicago—A. Batik, c/o A. Charvart, Archt., 262 Millard Ave. — artificial ice equipment.

Ill., Chicago—The Bunge Bros. Coal Co., 1648 West Lake St.—one little giant road crane, (used).

Ind., Gary—The Amer. Pure Paint Co.—grinding machine or pulverizer.

Mich., Detroit—The Schwartz Upholstering Co., 205 Moffat Bld., M. Schwartz, Purch. Agt.—general wood-working equipment, joining machines, etc.

Mich., Munising—The Munising Paper Co. —traveling crane.

O., Cleveland—P. Clinton, 3512 Central Ave.—shoe manufacturing machinery.

O., Columbus—The Buckeye Casket Co., 371 South High St., E. B. Rardin, Genl. Mgr. — wood-working machinery including saws, planers, etc.

Wis., Rice Lake — K. Knudson and S. Hegna—machinery for sash and door factory.

Wis., Ripon—The Ripon Handle & Specialty Co., L. Hall, Purch. Agt.—wood-working machinery.

Ont., Tilbury—The Ontario Flax Co. — machinery and equipment.

Metal Working

NEW ENGLAND

Conn., Hartford—N. Goldstein, 593 Windsor St., plans to build a 1 story garage, etc., on Morgan St. Estimated cost, $50,000. F. C. Walz, 407 Trumbull St., Archt.

Conn., New Haven — T. E. Guest, 71 Tower Rd., Waterbury, has awarded the contract for the construction of a 1 story, 30 x 45 ft. service station on Sperry St., here. Estimated cost, $17,000.

Conn., New Haven—The Tidewater Oil Corp., Wood St., will construct a 1½ story, 40 x 100 ft. oil warehouse and storage building and a 1 story, 40 x 50 ft. garage. Estimated cost, $25,000.

Conn., Windsor — The Windsor Garage has awarded the contract for the construction of a 1 story, 55 x 75 ft. addition on Windsor Ave.

Mass., Chicopee—G. P. Dion, 30 Center St., is preparing plans for the construction of a 1 story, 50 x 90 ft. garage on Center St. Estimated cost, $20,000.

Mass., Cohasset—The South Shore Garage, Inc., is having plans prepared for the construction of a 1 story, 30 x 80 ft. addition to its garage. Estimated cost, $10,000. G. F. Newton, 6 Beacon St., Boston, Archt.

Mass., Dorchester—I. Lesser, 3 Fayston St., Roxbury, will build a 1 story, 100 x 125 ft. garage on Mt. Vernon St. Estimated cost, $50,000.

Mass., Gardner — The Gardner Steam Laundry, Pine St., plans to build a 1 story garage and laundry. Estimated cost, $50,000. P. Varney, 25 Exchange St., Lynn, Archt.

Mass., Lynn — A. Attridge, Marblehead, will soon award the contract for the construction of a 1 story, 70 x 82 ft. garage on Chestnut St., here. Estimated cost, $35,000. E. F. Earp, 333 Union St., Archt. Noted Dec. 9.

Mass., New Bedford—The New Bedford Shuttle Co., 24 Elm St., will build a 2 story, 40 x 125 ft. addition to its factory on Rockdale Ave. Estimated cost, $40,000.

Mass., Pittsfield — J. North, Ontario St., has awarded the contract for the construction of a 2 story, 25 x 40 ft. garage and dairy building. Estimated cost, $10,000.

Mass., Worcester — The Aykroyd Iron Wks. Inc., 564 West Boylston St., has awarded the contract for the construction of a 1 story, 31 x 100 ft. machine shop, on Rochdale St. Estimated cost, $25,000.

Mass., Worcester—J. Johnson, 26 Spofford Rd., will build a 1 story, 48 x 136 ft. garage on Millbury St. Cost between $15,000 and $20,000.

Mass., Worcester—A. F. Mathieu, c/o J. Rice, Archt., 306 Main St., plans to build a 2 story, 60 x 180 ft. L-shaped garage on Pleasant and Fruit Sts. Estimated cost, $150,000.

Mass., Worcester — The Reed & Prince Mfg. Co., Duncan Ave., has awarded the contract for the construction of a 1 story, 40 x 290 ft. addition to its plant, for the manufacture of screws. Estimated cost, $10,000.

N. H., Exeter—A. E. McRell is having plans prepared for the construction of a 2 story, 40 x 150 ft. garage. Estimated cost, $40,000. J. E. Baker, 1008 Elm St., Manchester, Archt.

R. I., Pawtucket—The Farber Cornice Wks., 52 East Ave., has awarded the contract for the construction of a 2 story, 50 x 100 ft. plant on Pine St. Estimated cost, $30,000.

R. I., Providence—W. H. Farrell, Lockwood St., has awarded the contract for the construction of a 1 story, 60 x 66 x 83 ft. garage and showroom on Lockwood and Haskins Sts. Estimated cost, $20,000.

R. I., Providence — L. Michelovitch, c/o J. A. Hickey, Archt., 142 Atlantic Ave., will soon award the contract for the construction of a 1 story garage on South Main and Dollar Sts. Estimated cost, $15,000.

Vt., Springfield—Gilmore & Co. plans a 2 story, 50 x 150 ft. mill, for the manufacture of lathes to be used for turning out irregular wood articles.

Vt., Windsor — The Windsor Fdry. Co., plans to build a 1 story, 115 x 250 ft. foundry.

MIDDLE ATLANTIC STATES

D. C., Washington — The Chesapeake & Potomac Telephone Co., 725 13th St. N. W., is having plans prepared for the construction of a 2 story, 135 x 167 ft. garage near 1st St., N. E. Estimated cost, $100,000. C. T. Clagatt, Dir. Mgr. McKenzie Voorhees & Gmelin, 1123 Bway, New York City, Archts.

Md., Baltimore—W. E. Hooper & Sons Co., Parkdale Rd., manufacturers of cotton duck, has awarded the contract for the construction of a 1 and 2 story, 28 x 34 ft. and 12 x 49 ft. additions to its machine shop, on Parkdale Rd. and Druid Hill Park. Estimated cost, $60,000. Noted Dec. 9.

N. Y., Long Island City—Rolls Royce of America, Inc., 785 5th Ave., New York City, is having preliminary plans prepared for the construction of a 1 story service station and salesroom on Harris Ave. Estimated cost, $75,000. Ballinger & Perrott, 47 West 34th St., New York City, Archts. and Engrs.

N. Y., New York (Borough of Bronx)—The Edel Realty Co., 1901 Walton Ave., is having plans prepared for the construction of a 1 story, 50 x 246 ft. garage on Jerome Ave. Estimated cost, $75,000. J. E. Kirby, 4187 Park Ave., New York City, Archts.

N. Y., New York (Borough of Bronx)—T. Johnson, 30 East 42nd St., New York City, will build a 1 story, 25 x 112 ft. garage on Whitlock Ave. near Longwood Ave. Estimated cost, $30,000.

N. Y., New York (Borough of Bronx)—The Shaskin Realty Co., 220 Bway., New York City, will build a 2 story, 75 x 225 ft. garage on Inwood Ave. near 170th St. Estimated cost, $60,000. G. Shaskin, pres.

N. Y., New York (Borough of Brooklyn)—The Bay Ridge Land & Improvement Co., 189 Montague St., will build a 1 story, 110 x 120 ft. garage on 4th Ave. and 62nd St. Estimated cost, $30,000. R. Bennett, Pres.

N. Y., New York (Borough of Manhattan)—M. C. Haims, c/o H. Lippman, Archt. and Engr., 126 East 59th St., will build a 4 story, 34 x 98 ft. garage at 130-132 East 41st St. Estimate cost, $40,000.

N. Y., New York (Borough of Manhattan)—The Hester Realty Co., c/o G. H. Streeton, Archt., 115 East 34th St., will build a 1 story, 100 x 125 ft. garage at 555 West 34th St. Estimated cost, $30,000.

N. Y., New York (Borough of Manhattan)—The Rothbart Garage Corp., c/o J. M. Felson, Archt. and Engr., 1133 Bway, will build a 1 story, 120 x 125 ft. garage at 99 Jane St. Estimated cost, $35,000.

N. Y., New York (Borough of Manhattan)—The 16th St. Garage Corp., c/o C. Kreymbourg, Archt. and Engr., 309 East Kingsbridge Rd., will alter a 5 story garage at 235 West 16th St. Estimated cost, $50,000.

Pa., Charleroi—The Federal Fdry. Supply Co., 2633 East 79th St., Cleveland, O., plans to build a 2 story, 40 x 92 ft. factory here. Estimated cost, $30,000. Private plans.

Pa., Hollidaysburg—L. A. Brua, 304 Penn St., and E. H. Brua, 319 Alleghany St., will build a 2 story, 60 x 120 ft. garage and warehouse on Blair and Utica Sts.

Pa., Sharon—The Sharon Steel Hoop Co. is having preliminary plans prepared for the construction of a 2 story factory. Estimated cost, $150,000. J. H. Herron Co., 1360 West 3rd St., Cleveland, Archt. and Engr.

SOUTHERN STATES

Va., Richmond—S. G. Mercer and R. C. Trettan, 218 North 9th St., will build a 3 story, 40 x 50 x 140 ft. garage at 608 East Grace St. Estimated cost, $50,000.

Va., Roanoke—The F. N. Hayes Machine Co. plans to construct an addition to its plant.

MIDDLE WEST STATES

Ill., Chicago—The Narowetz Heating & Ventilating Co., 223 West Lake St., has awarded the contract for the construction of a 1 story, 81 x 132 ft. factory at 1711-17 West Park Ave. Estimated cost, $75,000.

Ill., Chicago—The United States Brewing Co., 2519 Elston Ave., will receive bids about Jan. 1, for the construction of a 1 story, 128 x 168 ft. garage on Grand Place near Clark St. Estimated cost, $40,000. W. Granger, 36 West Randolph St., Archt.

Ill., Peoria—The Peoria Auto Parts Co. has awarded the contract for the construction of a garage. Estimated cost, $20,000.

Ind., Lafayette—The Chicago, Indianapolis & Louisville Ry., (Monon Route), 608 South Dearborn St., Chicago, Ill., has awarded the contract for the construction of a 1 story, 85 x 440 ft. car repair shop, here. Estimated cost, $105,000. Noted Dec. 2.

Mich., Birch Run—W. R. Hadsell is having plans prepared for the construction of a 1 story, 110 x 147 ft. garage. Estimated cost, $26,000. Cowles & Mutscheller, Saginaw, Archts.

O., Cleveland—M. Goldstein, 2707 East 55th St., will receive bids until Dec. 28, for the construction of a 1 story, 50 x 56 ft. factory for auto repairs. Estimated cost, $15,000. Private plans.

O., Cleveland—The Mall Motor Co., 632 Superior Ave., has purchased a site on Superior Ave. and East 12th St. and plans to build a 2 story, 120 x 160 ft. garage. Estimated cost, $250,000. M. Rohrheimer, Pres. Christian, Schwarzenberg & Gaede, 1900 Euclid Ave., Archts.

O., Cleveland—J. Meyerhoffer, 8039 Superior Ave., is building a 1 story, 20 x 68 ft. garage at 8025 Superior Ave. Estimated cost, $10,000.

O., Cleveland—P. Priesz, 1850 West 24th St., will soon award the contract for the construction of a garage at 1925 West 24th St. Estimated cost, $15,000. F. Azzarello, 2500 East 20th St., Archt.

O., Cleveland—The Telling Belle Vernon Co., 3825 Cedar Ave., has awarded the contract for the construction of a 1 story, 30 x 160 ft. garage and stable at 704 Eagle Ave. Estimated cost, $30,000. Noted Dec. 9.

O., Cleveland — The Vcela Building & Loan Co., c/o A. Klipec, 5703 Bway., has awarded the contract for the construction of a 1 story, 20 x 63 ft. garage at 5703 Bway. Estimated cost, $10,000.

Wis., Sheboygan—H. H. Schmidt, c/o C. Reiss Coal Co., is having plans prepared for the construction of a 2 or 3 story, 60 x 185 ft. garage on Jefferson and 8th Sts. Cost, between $75,000 and $100,000. R. R. John, Betsy Ross Bldg., Archt.

WEST OF THE MISSISSIPPI

Kan., Wichita—The Clear Vision Pump Co., 1107-1109 East Douglas St., is building a 120 x 320 ft. plant for the manufacture of clear vision dispensing measures.

WESTERN STATES

Cal., Los Angeles—The Ambassador Hotel Co., c/o Alexander Hotel, 210 West 5th St., has awarded the contract for the construction of a hotel, theater and garage. Estimated cost, $350,000.

Cal., Los Angeles — P. L. Wilson, 631 South Sprague St., plans to construct a garage, machine shop, and store building, on the corner of Bonnie Brae and 7th Sts. Cost to exceed $70,000. Walker & Eisen, Hibernian Bldg., Archts.

CANADA

Ont., Goderich — The Huron Specialties Castings Co., Clinton, plans to build a plant here. Estimated cost, $75,000.

Ont., Woodstock—The Amer. Ironing Machine Co., 168 North Michigan Ave., Chicago, Ill., plans to remodel and equip a factory here for its own use. Estimated cost, $100,000.

General Manufacturing

NEW ENGLAND STATES

Me., Rockland—The Rockland & Rockport Lime Co. will build an addition to its lime plant, to include 6 lime kilns and gas producers, 1 story, 35 x 100 ft. main building and a 2 story, 60 x 108 ft. lime storage and packing house.

Mass., Cambridge — The E. & R. Co., Massachusetts Ave. and Windsor St., has awarded the contract for the construction of a 1 story dry cleaning plant and laundry. Estimated cost, $20,000. Noted Dec. 2.

Mass., Chicopee—The Dwight Mfg. Co., Exch. Bldg., Boston, has awarded the contract for the construction of a 6 story, 150 x 600 ft. addition to its cotton plant, here.

Mass., Newtonville—The Strangman Mfg. Co., Crofts St., manufacturers of builders finish, will build a 1 story, 85 x 105 ft. addition to its plant. Estimated cost, $20,000.

Mass., Oxford—A. G. Stanhope, 340 Main St., Worcester, plans to build a 2 story, 75 x 100 ft. cold storage plant. Estimated cost, $40,000.

Mass., Westfield — The Certified Foods, Inc., Gillett Bldg., plans to build a 2 story, 30 x 50 ft. plant. Estimated cost, $25,000. Jarvis Eng. Co., 261 Franklin St., Boston, Engrs.

Mass., Westerly — The Westerly Textile Co., 41 Main St., plans to build a 2 story addition to its textile plant on Main St. Estimated cost, $50,000. C. T. Main, 201 Devonshire St., Boston, Engr.

MIDDLE ATLANTIC STATES

N. J., Trenton—The Sanitary Ice & Coal Co., Old Rose St., plans to build a large ice-cream cold storage building. W. B. Maddock, 42 Division St., Pres.

Md., Baltimore — A. Thompson Co., 501 Water St., plans to build a 2 story, 100 x 200 ft. printing plant on 29th St. and Remington Ave. Estimated cost, $75,000.

SOUTHERN

Fla., St. Petersburg—The Williams-Beers Ice Co., is having plans prepared for the construction of an ice plant. H. Williams, Pres. H. Beers, St. Petersburg, Engr.

Ky., Franklin—The Western Kentucky Oil & Refining Co. is having preliminary plans prepared for the construction of an oil refining plant.

La., Bastrup—L. H. Fox has awarded the contract for the construction of a reduction plant, to include three 2 story, 50 x 200 ft. buildings and four 1 story, 30 x 60 ft. buildings. Estimated cost, $200,000.

N. C., Andrews—F. P. Cover & Sons, Inc., plan to build a tannery.

N. C., Hickory—The Catawba Creamery Co. plans to rebuild its creamery to include packing plant and refrigerating rooms, which was recently destroyed by fire. Estimated cost, $30,000.

N. C., Winston-Salem—The Blue Ridge Ice & Coal Co. plans to build an ice manufacturing plant. Estimated cost, $75,000. G. M. Hinshaw, Pres.

MIDDLE WEST STATES

Ill., Chicago—A. Batik, c/o A. Charvart, Archt., 2621 Millard Ave., has had plans prepared for the construction of a 3 story, 40 x 120 ft. artificial ice plant. Estimated cost, $60,000.

Ind., Gary—The Amer. Pure Paint Co. is building a 40 x 100 ft. plant for the manufacture of paint pigment and putty. Estimated cost, $30,000. W. J. Schroeder, Secy.

Ind., Logansport—The Sandusky Cement Co., c/o E. J. Maguire, Secy., Engineers Bldg., Cleveland, O., plans to construct a 1 story, 46 x 102 ft. factory and storage building here. Estimated cost, $50,000.

O., Cleveland—The Crossley Rubber Co., 2170 East 18th St., has awarded the contract for the construction of a 1 story, 30 x 40 ft. factory. Estimated cost, $10,000.

O., Cleveland—Glenville Hospital, c/o A. White, 701 Parkwood Dr., has awarded the contract for the construction of a 2 story, 40 x 40 ft. boiler house and addition to its laundry. Estimated cost, $40,000. Noted Oct. 14.

O., Cleveland—A. Jicha, 11006 Woodland Ave., baker, has awarded the contract for the construction of a 1 story, 35 x 91 ft. factory at 4215 East 131st St. Estimated cost, $15,000.

O., Cleveland—The Ohio Granite & Marble Co., 538 Schofield Bldg., plans to build a 1 story factory on Pearl Rd. Estimated cost, $100,000. G. W. Haskins, Secy. Private Plans.

O., Cleveland—C. Webber, c/o F. Dieffenback, 3217 West 92nd St., has awarded the contract for the construction of a 2 story, 40 x 56 ft. commercial building and bakery on West 25th St. Estimated cost, $75,000.

O., Greenville—The Consumers Supply Co. plans to build a 2 story, 60 x 120 ft. factory for the manufacture of fence posts. Estimated cost, $25,000.

O., Lima—The Crystal Ice & Coal Co. has awarded the contract for the construction of a 1 story ice plant. Estimated cost, $25,000.

Wis., Cedarburg—The Wetzel Art Furniture Co., 1367 Green Bay Ave., Milwaukee, has awarded the contract for the construction of a 2 story, 40 x 120 ft. factory on Main St., here, for the manufacture of furniture. Estimated cost, $75,000.

Wis., Chippewa Falls—The Bd. of School Trustees will receive bids about Feb. 1 for the construction of a 2 story, 125 x 160 ft. addition to the junior vocational school, to include a manual training department. Estimated cost, $150,000. Beers, Schlintz & Bailey, Chippewa Falls, Engrs.

Wis., Granville—The T. J. Moss Tie Co., Security Bldg., St. Louis, Mo., has awarded the contract for the construction of a 1 story, 40 x 200 ft. creosoting plant.

Wis., Rice Lake—K. Knudson and S. Hegna plan to build a sash and door factory.

Wis., Sheboygan—The Sheboygan Cold Storage Co., c/o E. C. Peacock, South 12th St. and Jefferson Ave., plans to build a 2 or 3 story, 100 x 250 ft. cold storage plant on West Water St., to replace the one which was recently destroyed by fire. Loss between $350,000 and $400,000.

Wis., South Milwaukee—The Line Material Co. has awarded the contract for the construction of a 1 story, 100 x 180 ft. factory for the manufacture of lighting equipment. Estimated cost, $30,000.

WEST OF THE MISSISSIPPI

Col., Ault—The Great Valley Sugar Co., Central Savings Bank Bldg., Denver, has awarded the contract for the construction of a sugar factory, here. Estimated cost, $1,000,000.

Ia., Cedar Rapids—The Hutchinson Ice Cream Co., 519 H St. W., will receive bids about Jan 10, for the construction of a 2 story, 60 x 100 ft. factory on 5th Ave. and 3rd St. E. Estimated cost, $50,000. Hatton, Holmes & Anthony, 323 Masonic Temple, Archts.

Ia., Sioux City—The Zonta Tire & Rubber Co. has awarded the contract for the construction of a 1 story, 100 x 120 ft. factory.

Mo., Maplewood (St. Louis P. O.)—The St. Louis Paper Can and Tube Co., 4400 North Union Ave., St. Louis, has awarded the contract for the construction of a 1 story, 200 x 540 ft. factory on Big Bend Rd. along the tracks of the Missouri, Pacific R.R. Estimated cost, $500,000.

Mo., St. Louis—The Brecht Packers Supply Co., 1201 Cass Ave., has awarded the contract for the construction of a 2 story, 73 x 74 ft. factory, at 1215 Cass Ave. Estimated cost, $20,000.

Mo., St. Louis—The Fleischmann Yeast Co., 1535 Market St., plans to build a 1 story, 75 x 170 ft. factory on Forest Park Blvd., east of Bogal Ave. Estimated cost, $50,000.

Tex., Fort Worth—The Mid West Petroleum Co. plans to build a refinery to have a daily capacity of 2,000 bbl.

CANADA

B. C., Prince George—F. Jones, Pres. of the Canada Cement Co., 273 Craig St. W., Montreal, and C. Gordon, Pres. of the Dominion Textile Co., 112 St. James St., Montreal, are interested in a syndicate which plans to build a pulp and paper plant here. Estimated cost, $6,000,000.

Ont., Tilbury—The Ontario Flax Co. plans to rebuild its flax mill which was recently destroyed by fire. Estimated loss, $75,000.

Ont., Guelph—The Provincial Government, Toronto, plans to build a dairy in connection with the agricultural college, here. Estimated cost, $100,000. Address, M. Doherty, Toronto.

Service Value

Scrap value for idle used machinery or surplus material is not enough. If it can be used by others they will pay *service value* for it. "Searchlight" will find these buyers for you.

Manufacturers who accept used machinery in part payment for new can dispose of it promptly by advertising in the Searchlight Section.

Machinery used in manufacturing and displaced by other equipment can be sold at a fair price by advertising it in the Searchlight Section.

Wide-awake dealers, agents or representatives can be secured through little Searchlight "Want" ads.

Manufacturing sites, partners, help, capital —anything that anybody in the machinery field is likely to have for sale or exchange for something else—can be located or disposed of through the Searchlight Section.

The cost of putting your Wants in this projector is very slight, whether for a man, for a job or for a market.

Searchlight Section

Pages 212 to 234